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NOAA Technical Memorandum NESS 109

NATIONAL ENVIRONMENTAL SATELLITE SERVICE CATALOG OF PRODUCTS, THIRD EDITION

Washington, D.C.
April 1980

U.S. DEPARTMENT OF COMMERCE / National Oceanic and Atmospheric Administration / National Environmental Satellite Service

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NESS 76 The Use of the Radiosonde in Deriving Temperature Soundings From the Nimbus and NOAA Satellite Data. Christopher M. Hayden, April 1976, 19 pp. (PB-256-755/AS)

NESS 77 Algorithm for Correcting the VHRR Imagery for Geometric Distortions Due to the Earth Curvature, Earth Rotation, and Spacecraft Roll Attitude Errors. Richard Legeckis and John Pritchard, April 1976, 31 pp. (PB-258-027/AS)

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(Continued on inside back cover)

NOAA Technical Memorandum NESS 109

NATIONAL ENVIRONMENTAL SATELLITE SERVICE CATALOG OF PRODUCTS, THIRD EDITION

Dennis C. Dismachek,
Arthur L. Booth, and
John A. Leese

Washington, D.C.
April 1980

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DEPARTMENT OF COMMERCE
Philip M. Klutznick, Secretary

NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION
Richard A. Frank, Administrator

National Environmental
Satellite Service
David S. Johnson, Director

PREFACE

This third edition of the National Environmental Satellite Service - Catalog of Products is published to provide information on the operational products and services of NESS. These are available for use by industry, researchers, Federal and local government agencies, and others who may have need for, or interest in them. The information provided here was compiled by Dennis C. Dismachek of Systems and Applied Sciences Corporation, Riverdale, Maryland, in conjunction with Arthur L. Booth and John A. Leese of the National Environmental Satellite Service, Suitland, Maryland.

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ACRONYMS, ABBREVIATIONS, AND TERMS

AID	Agency for International Development
APT	Automatic Picture Transmission
ATS	Applications Technology Satellite
AVHRR	Advanced Very High Resolution Radiometer
BWB	Basic Weather Branch (of NMC)
CDA	Command and Data Acquisition (Station)
CRT	Cathode Ray Tube
DCS	Data Collection System
DDHF	Digital Data Handling Facility
DMD	Digital Muirhead Display
DMSP	Defense Meteorological Satellite Program
DOD	Department of Defense
EDIS	Environmental Data and Information Service
ERL	Environmental Research Laboratories
GAC	Global Area Coverage
GMS	Geostationary Meteorological Satellite
GMT	Greenwich Mean Time
GOES	Geostationary Operational Environmental Satellite
GOSSTCOMP	Global Operational Sea Surface Temperature Computation
Gridding	Implanting of latitude/longitude grid lines and geographic boundaries into imagery
GTS	Global Telecommunications Service
HEPAD	High Energy Proton-Alpha Detector
HIRS	High Resolution Infrared Sounder
HRPT	High Resolution Picture Transmission
IR	Infrared
ITCZ	Intertropical Convergence Zone
ITOS	Improved TIROS Operational Satellite
km	Kilometer
Kev	Kilo-electron volt
LAC	Local Area Coverage
M	Million
Mapped	Treatment of imagery to include both gridding and rectification
mb	Millibar
MEPED	Medium Energy Proton and Electron Detector
Mev	Million-electron volt
MMIPS	Man/Machine Interactive Processing System
MSU	Microwave Sounder Unit
NAFAX	National Facsimile Network
NAMFAX	National Meteorological Facsimile Network
NASA	National Aeronautics and Space Administration
NCC	National Climatic Center
NESS	National Environmental Satellite Service
NMC	National Meterological Center
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration

NWS	National Weather Service
PIREP	Pilot Report
QPB	Quantitative Precipitation Branch (of NMC)
Rectification	Transposition of data points in a field of imagery from raw position to reflect a particular map projection, i.e., polar-stereographic or Mercator
RFC	River Forecast Center
SDSD	Satellite Data Services Division
SEM	Space Environmental Monitor
SFSS	Satellite Field Service Station
SMS	Synchronous Meteorological Satellite
SSD	Satellite Services Division
SST	Sea Surface Temperature
SSU	Stratospheric Sounder Unit
TED	Total Energy Detector
TIROS	Television Infrared Observation Satellite
TOS	TIROS Operational Satellite
TOVS	TIROS Operational Vertical Sounder
VHR	Very High Frequency
VIS	Visible
VISSR	Visible and Infrared Spin Scan Radiometer
WEFAX	Weather Facsimile
WWB	World Weather Building
Z	Greenwich Mean Time

NOAA PRODUCTS AND SERVICES OF THE NATIONAL ENVIRONMENTAL SATELLITE SERVICE

Compiled by: Dennis C. Dismachek,
Arthur L. Booth and
John A. Leese

ABSTRACT. This volume of the NOAA Products and Services has been compiled to provide users with a description of all the currently available operational products of the National Environmental Satellite Service (NESS). It is also an update to the National Environmental Satellite Service - Catalog of Products (Dismachek, 1977). A Product is defined as any item routinely produced and available for applications within the environmental sciences. These range from photographic displays, charts, and teletype messages to the raw alphanumeric data available on computer disk and tape. A brief description of the product, its known accuracies (when applicable), a list of primary users, and an example of the product are given; a summary table of products can be found at the end of this volume for quick reference.

INTRODUCTION

A. Background

When TIROS-1 was launched in 1960, the first satellite "products" of interest to environmentalists were the basic cloud pictures. Soon thereafter, derived products took the form of analyses of significant weather, and before long nephanalyses for limited areas were being produced routinely. With a change in camera mounting on TIROS-9, the first view of the entire global cloud structure was obtained. The TIROS Operational Satellite (TOS) series commenced in the mid-1960's with the launch of ESSA-1, and, with growing assistance from computers, the product line began to diversify.

Aside from documents describing the growing cloud picture archive (Key to Meteorological Records Documentation), need for a products catalog was evident, and in 1968 limited samples of a draft document were circulated for comment. Although a technical report (Leese et al. 1970) described the climatological aspects of data in satellite images, it soon was outdated as the operational product line continued to change. Experiments with spin/scan image data from NASA's geostationary Applications Technology Satellites (ATS) led to routine extraction of cloud motion wind estimates (Young et al. 1972) during the summer of 1969. Soon thereafter, the Improved TIROS Operational Satellite (ITOS) system provided sensors for indirect soundings (McMillin et al. 1973), as well as infrared

scanners for thermal target sensing (Leese et al. 1971) and for nighttime imaging (Conlan 1973).

The early 1970's saw the advent of the Synchronous Meteorological Satellite (SMS) and the Geostationary Operational Environmental Satellite (GOES) series, continually viewing the Western Hemisphere from a height of some 35,000 km above the earth's equator (Burr and Pipkin 1973). A refined visible and infrared channel selection (five channels as opposed to the former two), advances in atmospheric sounding techniques (provided by a three instrument system) and inclusion of a data collection and platform locator were combined in the third generation polar orbiting system, TIROS-N, launched into a sun-synchronous orbit in the late 1970's (Schwalb 1978). Currently two polar orbiting satellites of the TIROS-N series view the earth from a height of 850km at a rate of fourteen orbits per day each.

It was from this rapid development in environmental sensing and the continued growth of the product line that the first Catalog of Operational Satellite Products was published in March 1974 (Hoppe and Ruiz). Since then the catalog of operational products has become an increasingly useful aid to the user community. The products described herein are items routinely produced and available for application within the environmental sciences. These range from photographic displays, charts, and teletype messages to the raw data available on computer disk and tape. This catalog is an update to the National Environmental Satellite Service - Catalog of Products (Dismachek 1977) and has been designed to be easily updated as new products become available and old products are improved or replaced.

This catalog contains a brief description of each product. An effort to reveal the accuracy of each product, when applicable, has been made. Also, a list of primary users is included to point out the lines of product dissemination. Examples of each product are included with the description, whenever possible. Table 4, a summary table of products, can be found at the end of this volume for quick reference.

B. Data Sources

The spacecraft and sensor components have been described in detail elsewhere (Burr and Pipkin 1973, Schwalb 1978), but a brief review here may enable readers to better assess the potential applicability of the data to their missions.

The geostationary satellites of the SMS/GOES series are equipped with a Visible and Infrared Spin Scan Radiometer (VISSR), Space Environmental Monitor (SEM), and data-relaying capabilities. These satellites are in a geosynchronous orbit at an approximate altitude of 35,800 km over the equator, viewing the Western Hemisphere as shown in figure 1.

The VISSR sensor scans the full disk of the earth in 18.2 min (Ludwig 1975), viewing in the visible spectrum (0.55 to 0.75 μm), and in the infrared window region (10.5 to 12.6 μm). Visible data resolution is approximately 1 km, and infrared data resolution is approximately 8 km at the satellite subpoint.

The SEM sensors continuously monitor solar activity by measuring the flux of energetic particles, solar x-rays, and magnetic fields. These data are used for environmental research and in alerting ground communication systems of imminent solar storm activity.

The GOES-DCS provides the ability to collect and relay data from remotely located environmental monitoring platforms such as, buoys, river gauges, automatic weather stations, seismic and tsunami stations and manned ships. The satellite communication system provides for the transmission of VISSR, SEM, and local environment monitor data to primary receiving sites and also is used for the transmission of Weather Facsimile (WEFAX) data to local users (figure 2).

Polar-orbiting satellites of the TIROS-N/NOAA series are launched into near 850 km sun-synchronous (quasi-polar) orbits with equator crossings near 3:00 and 7:30 A.M. (descending node[1]) and 3:00 and 7:30 P.M. (ascending node) local sun time for spacecraft one and two respectively. Attitude determination is provided by an earth horizon detector, a sun sensor and a set of rate-integrating gyros which supply the needed information to earth for computerized control of onboard stabilizing magnetic coils and flywheels. The sensor payload includes the Advanced Very High Resolution Radiometer (AVHRR), High Resolution Infrared Sounder (HIRS/2), Stratospheric Sounder Unit (SSU), Microwave Sounder Unit (MSU), Data Collection System (DCS), and the Space Environment Monitor (SEM).

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[1] A spacecraft crossing the equator from north to south is on the descending part of the orbit, while a south-to-north crossing is called the ascending node.

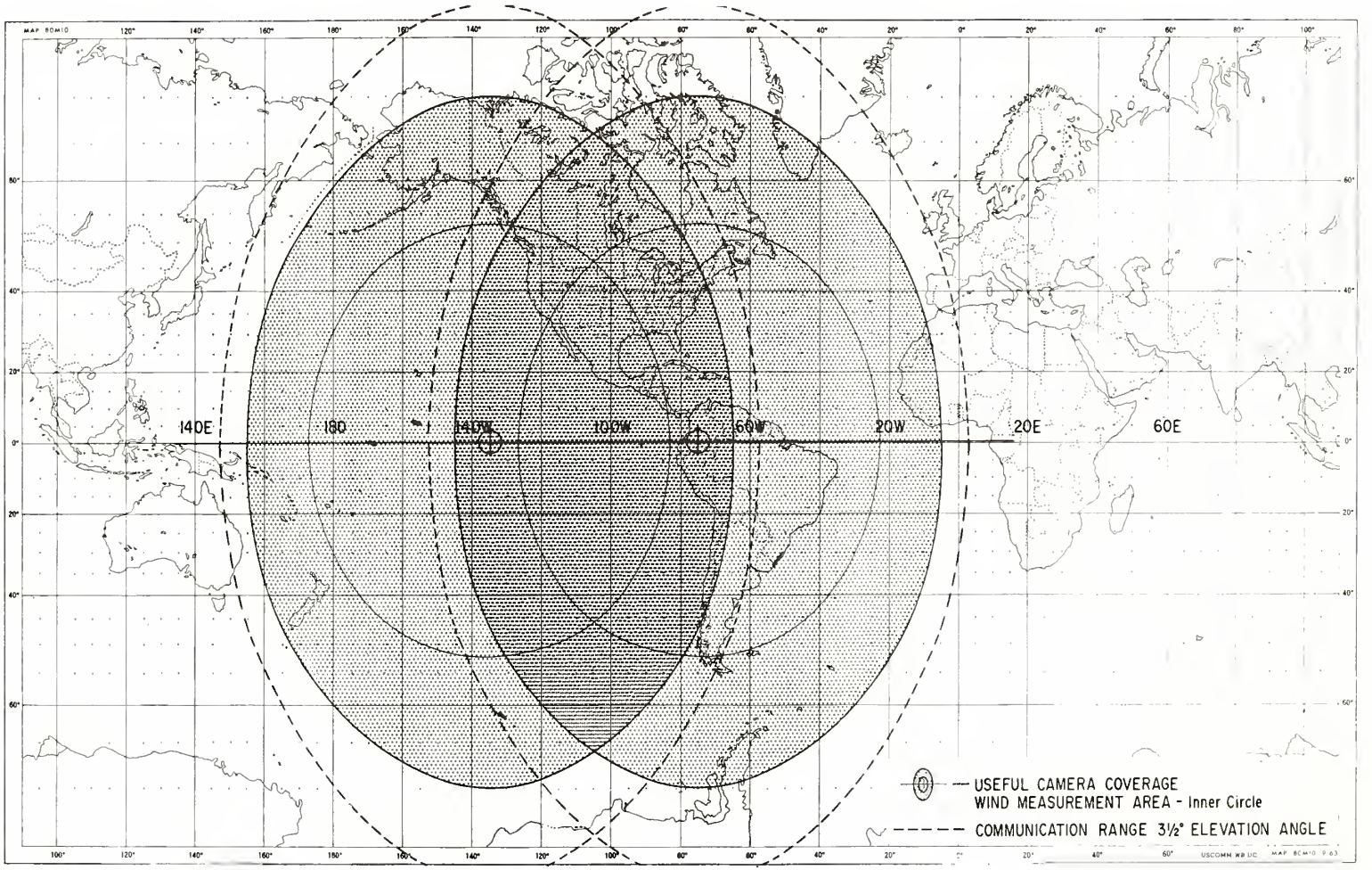


Figure 1. Approximate viewing and receiving area of SMS/GOES

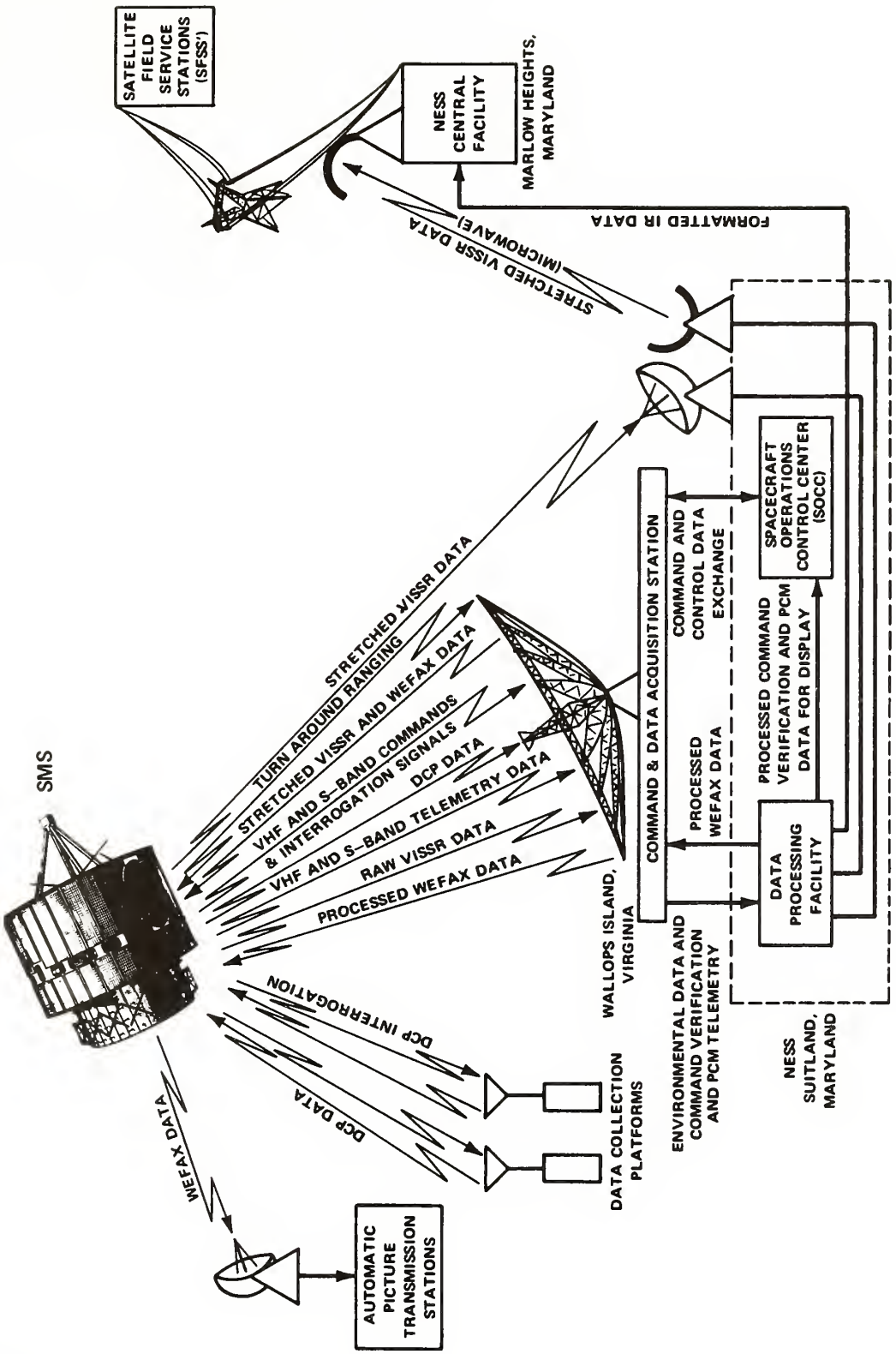


Figure 2. SMS/GOES System

The AVHRR is a five channel (0.62μm visible[1], 0.91 μm visible/near IR, 3.74 μm IR, 11.00 μm IR[2] and 12.00 μm IR[3]) imaging device that continuously scans in a horizon-to-horizon cross-track mode with scan steps provided by the forward motion of the spacecraft. Visible and infrared data resolution is approximately 1 km at the satellite subpoint.

The HIRS/2, SSU and MSU instruments are functionally separate units of the TIROS Operational Vertical Sounder (TOVS), combining the retrievals from 27 spectral channels to produce atmospheric temperature profiles from the surface to 10 mb, water vapor content of the atmosphere at three levels and total ozone content.

The DCS is designed to obtain environmental data from fixed or moving platforms (buoys, ships, balloons, etc.) while allowing for earth location of up to 4000 platforms in a 24 hour period. Information is received by a non-interrogating random access system which stores the data, signal frequency and time of occurence of each transmission for up to 459 platforms in view. All data stored are retransmitted to Command and Data Acquisition (CDA) stations or echoed back to ground stations in view of the satellite at receiving time, the latter transmission not containing earth location data. Earth location is performed by ground systems using the Doppler shift in frequency of successive platform transmissions.

The SEM is the same unit described under the SMS/GOES satellite series.

Data-relaying systems of the polar-orbiting satellites provide raw data readout of AVHRR, TOVS, DCS and SEM data to ground receiving stations around the world having Automatic Picture Transmission (APT) and modified S-Band High Resolution Picture Transmission (HRPT) receiving equipment.

All sensor data for central processing are acquired by the NESS CDA stations at Gilmore Creek, Alaska, and Wallops Island, Virginia. Raw data signals are retransmitted via microwave and commercial communication satellites to Suitland, Maryland, where they enter a specialized Digital Data Handling Facility (DDHF) (Kahwajy 1970).

---

[1]The original TIROS-N model will have a 0.725 μm visible number one channel.

[2]Second generation AVHRR on future spacecraft will have a 10.8 μm IR number four channel.

[3]First generation AVHRR sensors will repeat channel four data.

Dedicated medium-scale computers within the facility are used to perform certain preprocessing tasks and to arrange the data for further treatment (Bristor 1971), by means of either manual analysis or large-scale computer.

The data stream arriving at Suitland, Maryland is recorded on a photofacsimile recorder, on digital magnetic tape, or on both (Doolittle et al. 1970). Again, the data are available for further manual treatment or as input for large-scale computer processing. Photographic imagery products are not available until at least 1-1/2 hours after receipt of signal at NESS. Photofacsimile recording time and photo lab processing time of about 45 minutes each account for this delay. In addition to these processing delays, certain photo products by their nature (e.g., end of day mosaics, multiday composites) contribute to the delay. Data flow of the geostationary and polar-orbiter systems are displayed in figures 2 & 3.

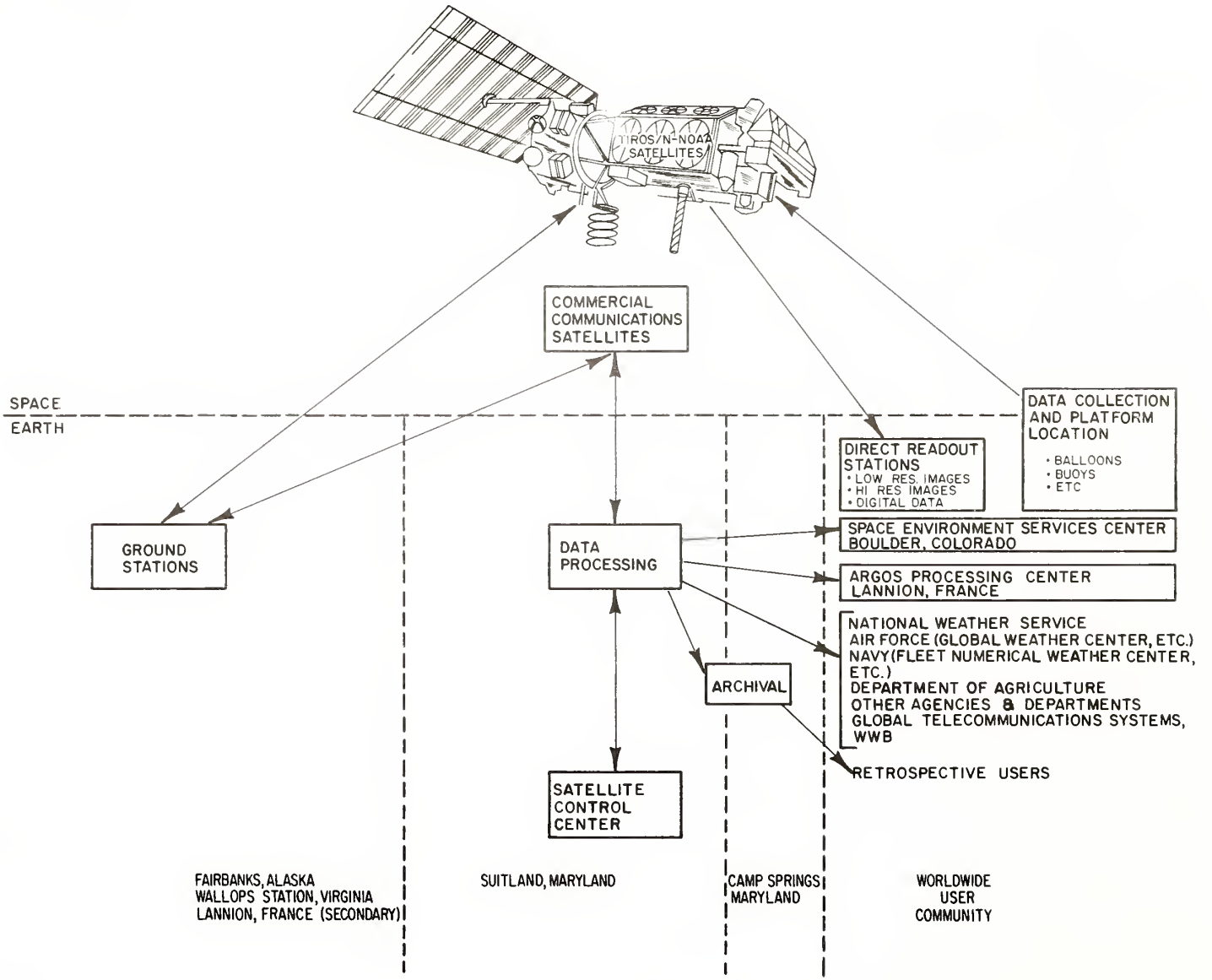


Figure 3. TIROS-N Spacecraft and data flow

C. Using the Satellite Products Catalog

This catalog has been constructed in a form that is clear, concise, and easily referenced. All products described are listed with their title, description, accuracy (when applicable), and primary users. An effort has been made to present an example of each product and any tables that might help to inform the user of what is available or where one might obtain data. Table 4 at the end of this volume is a product summary table for quick reference. For information on archived products, contact:

NOAA/EDIS/NCC
Satellite Data Service Division (SDSD)
World Weather Building, Room 100
Washington, D.C. 20233
Phone: FTS-763-8111 or Comm (301) 763-8111

The acronyms and abbreviations used in this catalog are listed in a table on page ix.

D. Data Availability

NESS satellite data products may be requested as follows:

Real-time products--By prior arrangement with NESS after which the product is produced routinely on a standing order in real time or in delayed time before the operational master (film, tape, or hard copy) has been archived. For these products, users supply their own communication links and pick up the product or arrange to have it mailed.

Requests for real-time products should be addressed to:

National Environmental Satellite Service (NESS)
Director of Operations, FB-4
Washington, D.C. 20233

Retrospective products--These are produced from operational masters that require search of the archives at the SDSD of the National Climatic Center (NCC), retrieval, preparation of copies, and refile of the master.

Requests for retrospective data products should be addressed to:

Satellite Data Services Division, NCC/EDIS
World Weather Building, Room 100 Phone: FTS-763-8111
Washington, D.C. 20233 or (301) 763-8111

Both NESS and the Environmental Data and Information Service (EDIS) operate under a user charge and service policy that requires the recovery of the cost of reproduction of satellite data products. The required charge will be specified during the initial arrangements for receipt of the data. Direct billing for these products is handled through NCC.

I. IMAGE PRODUCTS

A. Geostationary Satellites

1. Full-Disk and Sector Displays.

Description. The Satellite Services Division of NESS regularly distributes satellite photographic displays to the National Weather Service (NWS) offices and various other users. The data used to make these displays are obtained from the Visible Infrared Spin Scan Radiometer (VISSR) sensor on board the Synchronous Meteorological Satellite (SMS)/Geostationary Operational Environmental Satellite (GOES) series. The sensor continually views the regions shown in figure 1. Eight visible channels in the range of 0.55 to 0.75 μm and two infrared channels in the 10.5- to 12.6-μm wavelength region are viewed as the VISSR instrument scans across the earth (Bristor 1975). For a description of the "enhanced" infrared (IR) data (figure 5) that are available, see the Satellite Service Division's "GOES/SMS User's Guide."

Two complete full-disk data sets (one for the geostationary satellite over the subpoint 0.0° N. latitude, 135° W. longitude; the other for the subpoint 0.0° N. latitude, 75.0° W. longitude) are created at 15 and 45 min. after the hour and on the hour and the half hour, respectively. From these data sets, the full disks (figure 4) and various sectors (1-, 2-, 4-, and 8-km resolution) are produced. For each of these areas the image contains an equal amount of data points, thereby obtaining a finer resolution for the smaller regions. Each image contains a legend at the top and is available gridded or ungridded depending on the timeliness of data request.

Archive tapes are made daily containing one visible and five infrared sectors from each satellite from 8/9/76 to 9/6/78 and from 9/6/78 to the present, containing five VIS and thirteen IR images. Each sector consists of data viewed for approximately 105^{0} of latitude and 99° of longitude starting at 50° north latitude and centered in the east/west direction at the respective subsatellite positions. Both the infrared and the visible data are archived at 7.4-km (4-mile) resolution. The times of the data archived each day under normal conditions (times may differ by ± 1/2 to ± 1 hour) are given in table 1.

Full-disk and sector displays are very useful as a real-time source for the location of actual or potential severe weather and for issuing advisories to data-sparse areas, for following

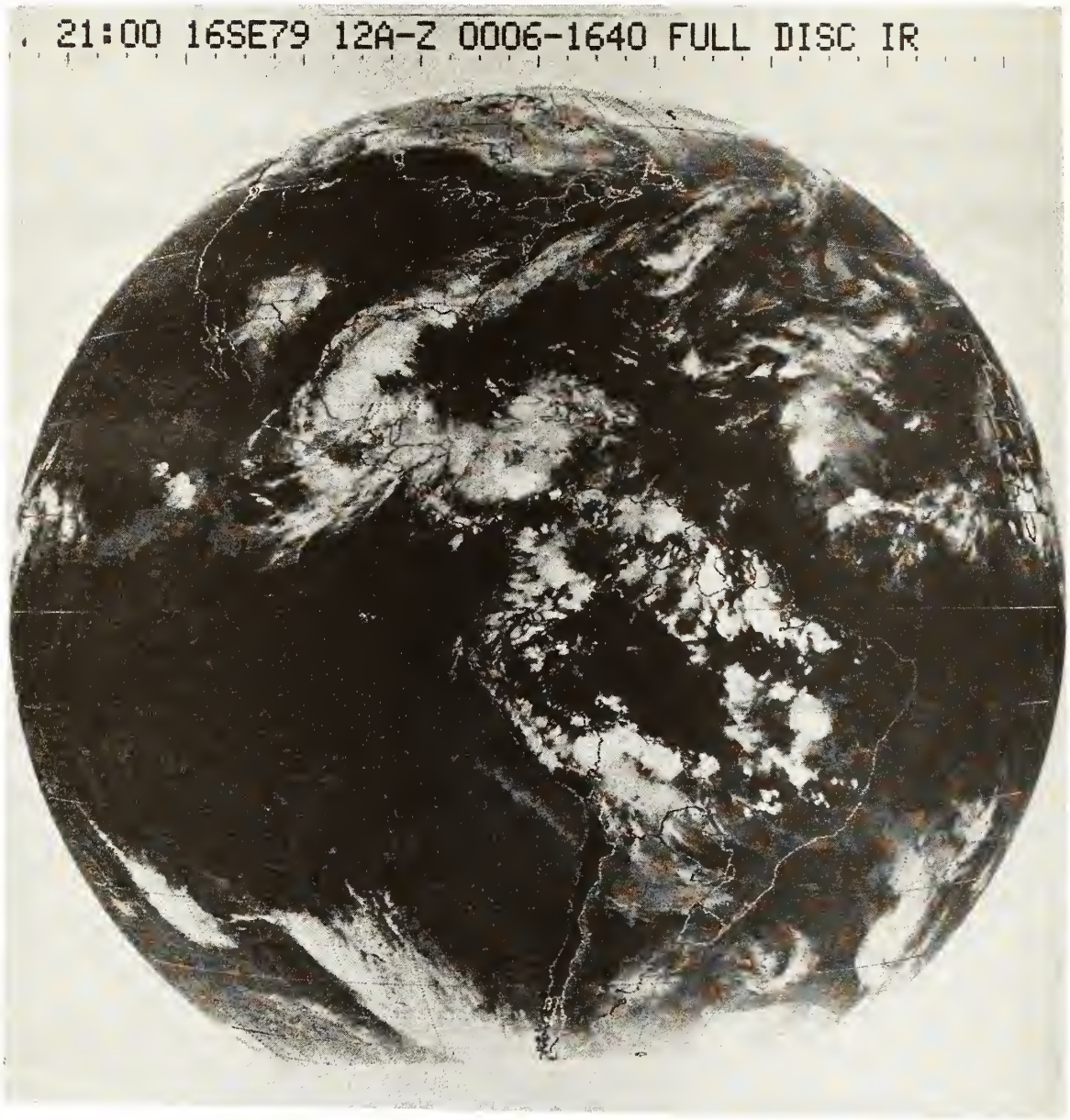


Figure 4. Full-Disk Photographic Image (gridded)

cloud motion and deducing wind speed and direction from successive pictures, and for use (in sequence) in producing movie loops. As a research tool or in alerting forecasters to potential areas of concern, the photographic images may be altered by enhancing the data displayed (figure 5). An enhancement can emphasize areas of interest such as cloud tops, stratus decks, fog areas, etc., by alteration in the "gray scale" used.

Accuracy. The photographic displays are available in 8-, 4-, 2-, and 1-km resolutions. Accuracy in the positioning of clouds and their movements is limited to the fit and proper locating of the map grid to the data displayed. Map grid fitting is dependent on the ability to accurately pinpoint the subpoint of the satellite (Bristor 1975).

Primary users. The full-disk and sector displays produced by NESS are used primarily by the National Weather Service (NWS), National Meteorological Center (NMC), internally in NESS, and by a number of other Government, university, and research concerns. All archived SMS/GOES data are handled by the Satellite Data Services Division (SDSD) of NCC in magnetic tape form.

Table 1 - Daily Archive of SMS/GOES Sectors

East		West	
0000Z	VIS&IR	0245Z	IR
0300Z	IR	0545Z	IR
0600Z	IR	0845Z	IR
0900Z	IR	1015Z	IR
0930Z	IR	1045Z	IR
1000Z	IR	1145Z	IR
1200Z	IR	1445Z	VIS&IR
1500Z	VIS&IR	1515Z	IR
1600Z	VIS&IR	1545Z	IR
1800Z	VIS&IR	1745Z	VIS&IR
2100Z	VIS&IR	2045Z	VIS&IR
2130Z	IR	2145Z	VIS&IR
2200Z	IR	2345Z	VIS&IR

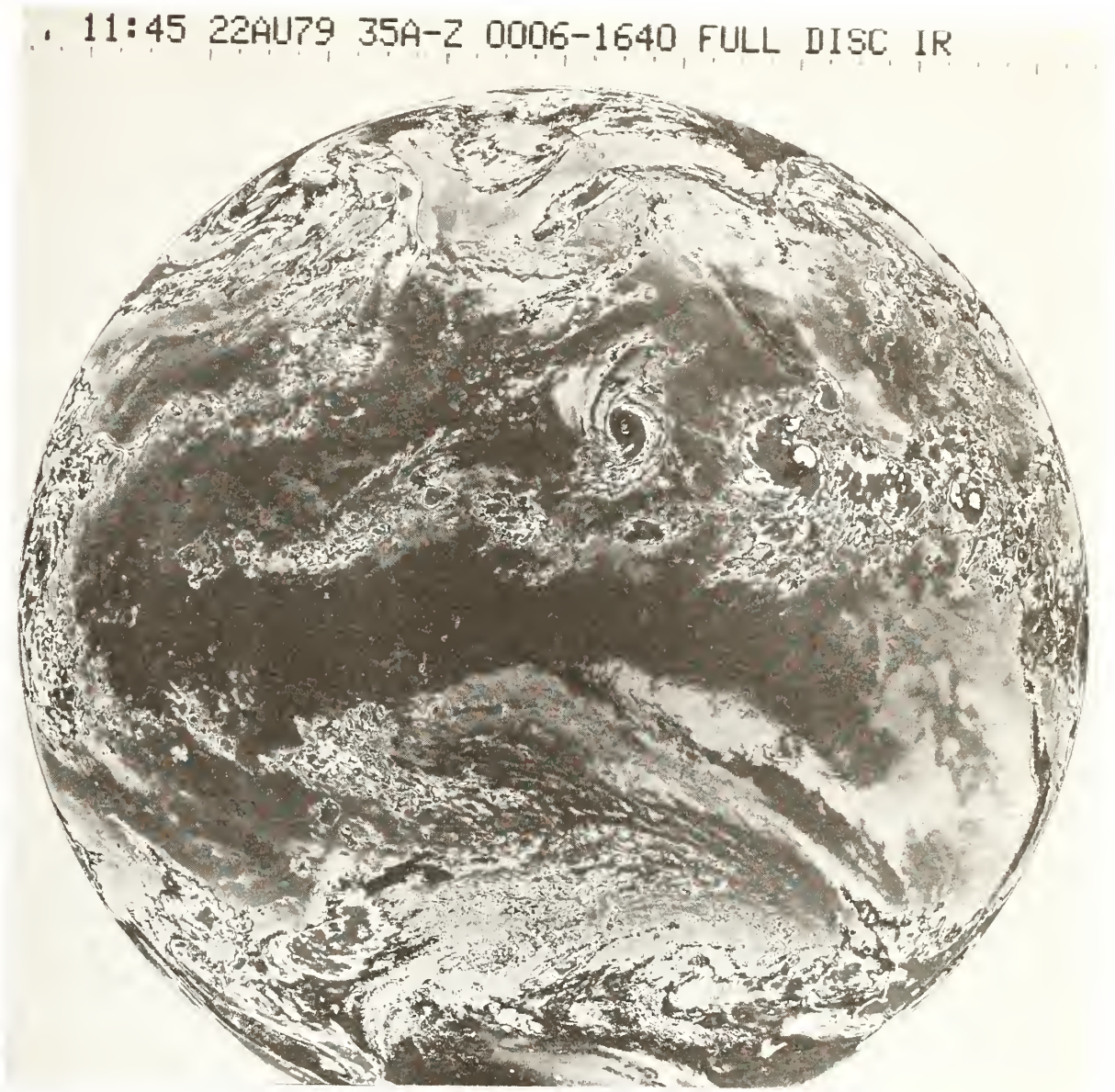


Figure 5. Enhanced Infrared Photographic Display

2. Movie Loops.

Description. The movie loops generated in NESS (Bristor 1975) are one of the tools used in the application of satellite data to weather forecasting and research. Movie loops also are produced for display by commerical television stations.

The data used for making movie loops are photographic images produced from the geostationary satellites' VISSR sensors. These data, either half hourly infrared or visible imagery, are combined into sequences of negatives to form a 16-mm movie loop.

Three types of movie loop presentations are generated--"stop," "flow," and "alternate stop." The movie loops consist of 80 or more frames, the lengths of which depend on whether the loop is a "stop" or a "flow." A stop loop has the beginning and end scenes repeated for a minimum of 16 frames, with intervening scenes repeated once, while an alternate stop loop has alternating flow and stop segments. The flow loop holds the first scene and repeats 4 to 26 subsequent scenes only once. Filmstrips created for commercial TV display are in the form of a "stop" but are not closed into a loop. These movies are put through a rigid quality-control procedure by man and computer software to assure evenness of illumination and proper registration. Each movie loop or strip contains the date and start and end times located in the lower right-hand corner. Table 2 comprises a list of movie loops currently used in-house by NESS. The names, areal coverage, and types of loops are subject to change without notice.

The satellite winds movie loops (see Satellite Winds under Meteorological Products) and the TV filmstrips are archived at the SDSD of the National Climatic Center (NCC). Movie loops prepared for the Applications Division are on file with them and are available to in-house personnel.

Primary Users. The movie loops are used by the Applications Division of NESS for its morning briefings. Another set of loops are prepared for the Interactive Processing Group for its winds program. TV filmstrips with a written discussion of the weather conditions (see Satellite Weather Summary) shown are available once per day to the commercial television networks.

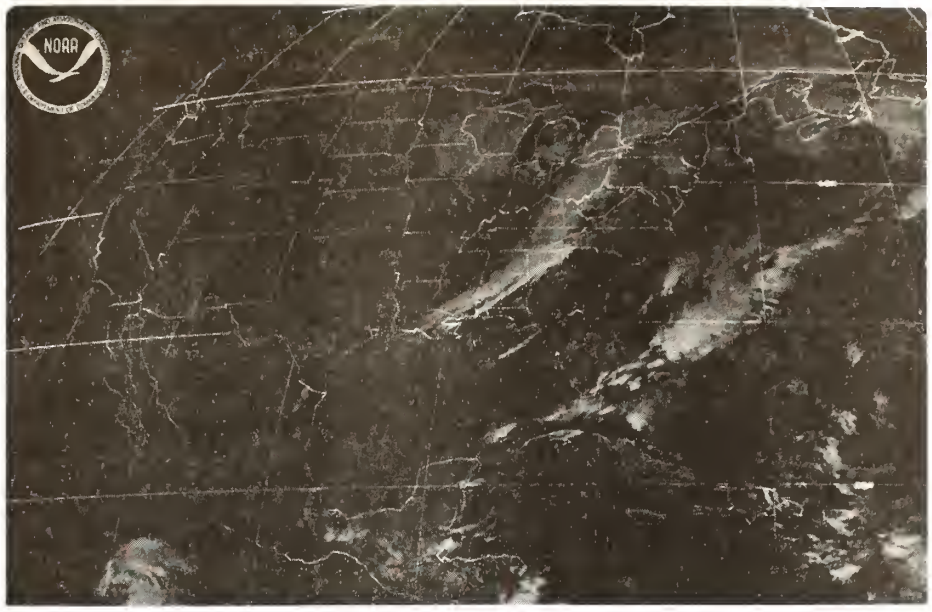
Table 2.--Movie loops available as of October 2, 1979

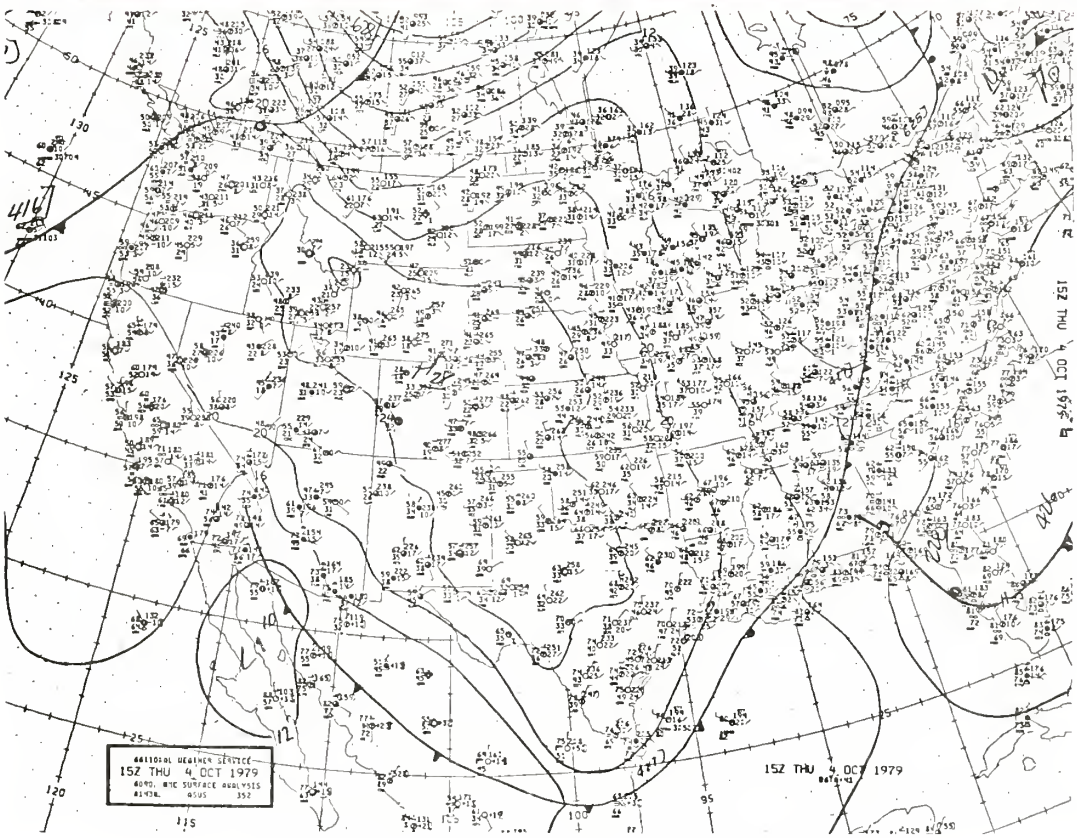
Sector	Description	Satellite	VIR/IR or IR-Enhanced	Resolution
FDIR, (6-18Z, 18-6Z)	Pacific Full Disk	West	IR	8 km
WB2	Eastern Pacific	West	VIS	2 km
FDIR (10-22Z; 22-10Z)	Northern Hemisphere Full Disk	East	IR	8 km
WC1	Atlantic Full Disk	East	VIS	4 km
FDIR	Atlantic Full Disk	East	Enhanced IR	8 km
WB1	North America	East	VIS	2 km
FDIR	North America	East	Enhanced IR	8 km
DA1	East Coast - U.S.	East	VIS	1 km
KA5	Upper Midwest - U.S.	East	VIS	1 km
GA	Gulf Coast - U.S.	East	VIS	1 km
SA1	Southwest - U.S.	West	VIS	1 km
SA2	Pacific Northwest	West	VIS	1 km
AB1	Alaska	West	VIS	2 km
WC2	Equatorial Pacific	West	VIS	4 km
FDIR	Equatorial Pacific	West	VIS	4 km
RRSD/PQ	Special Hurricane/ Tornado	East	VIS	1 km
FDIR	Special Hurricane/ Tornado	East	Enhanced IR	8 km
FDIR	TV filmstrip - U.S.	East	IR	8 km

3. U. S. Cloud Cover Depiction.

Description. The U.S. Cloud Cover Depiction is sent out to the news media wire services via landline and to in-house users by mail once per day. The product used in-house (figure 6) consists of a photographic display, normally the 17% image, an NMC 15% surface analysis, and a brief narrative description of the location of cloud cover and weather over the continental United States. These are approximately 20 by 25 cm in size. The wire services receive a photographic display and discussion combined for facsimile transmission. This product is useful for briefings and local displays of current weather.

Primary users. The U.S. Cloud Cover Depiction is used by members of NOAA Headquarters, NESS, Environmental Research Laboratories (ERL), NASA, Department of Defense, and the news media wire services. This product is archived by the SDSD of NCC.





GOES-EAST DAILY WEATHER PICTURE FOR: OCTOBER 4, 1979

A BAND OF FRONTAL CLOUDINESS EXTENDS SOUTHWARD FROM A LOW PRESSURE CENTER OVER SOUTHERN ONTARIO THROUGH THE OHIO VALLEY AND INTO THE GULF STATES. INTENSE THUNDERSTORMS EXTEND FROM NORTHERN GEORGIA TO SOUTHERN MISSISSIPPI. THIN HIGH CLOUDS ARE VISIBLE OVER THE SOUTHWEST.

Figure 6. U. S. Cloud Cover Depiction--Photographic Display, Surface Analysis, and Narrative Description

4. Daily Weather Picture

Description. The daily weather picture (figure 7) is a photographic display of weather affecting the continental United States as seen from GOES - East and a descriptive narrative of cloud cover and major weather events portrayed. A WB-1 sector of the full disk image is used to generate this product for dissemination to users three times per day in either a visible or infrared display depending on time of day viewed.

Primary Users. Commercial wire services for newspapers and television networks.

NESS 102901-10/29/79-WASHINGTON:Commerce Dept. satellite photo taken at 4:00 AM EST SHOWS an area of cloudiness over the Great Basin, northern Rockies, and the northern Plains. A band of clouds and thundershowers stretches from the northern Gulf of Mexico to the southern Appalachians. Low clouds over the eastern Lakes extend eastward through northern New England. (UPI)

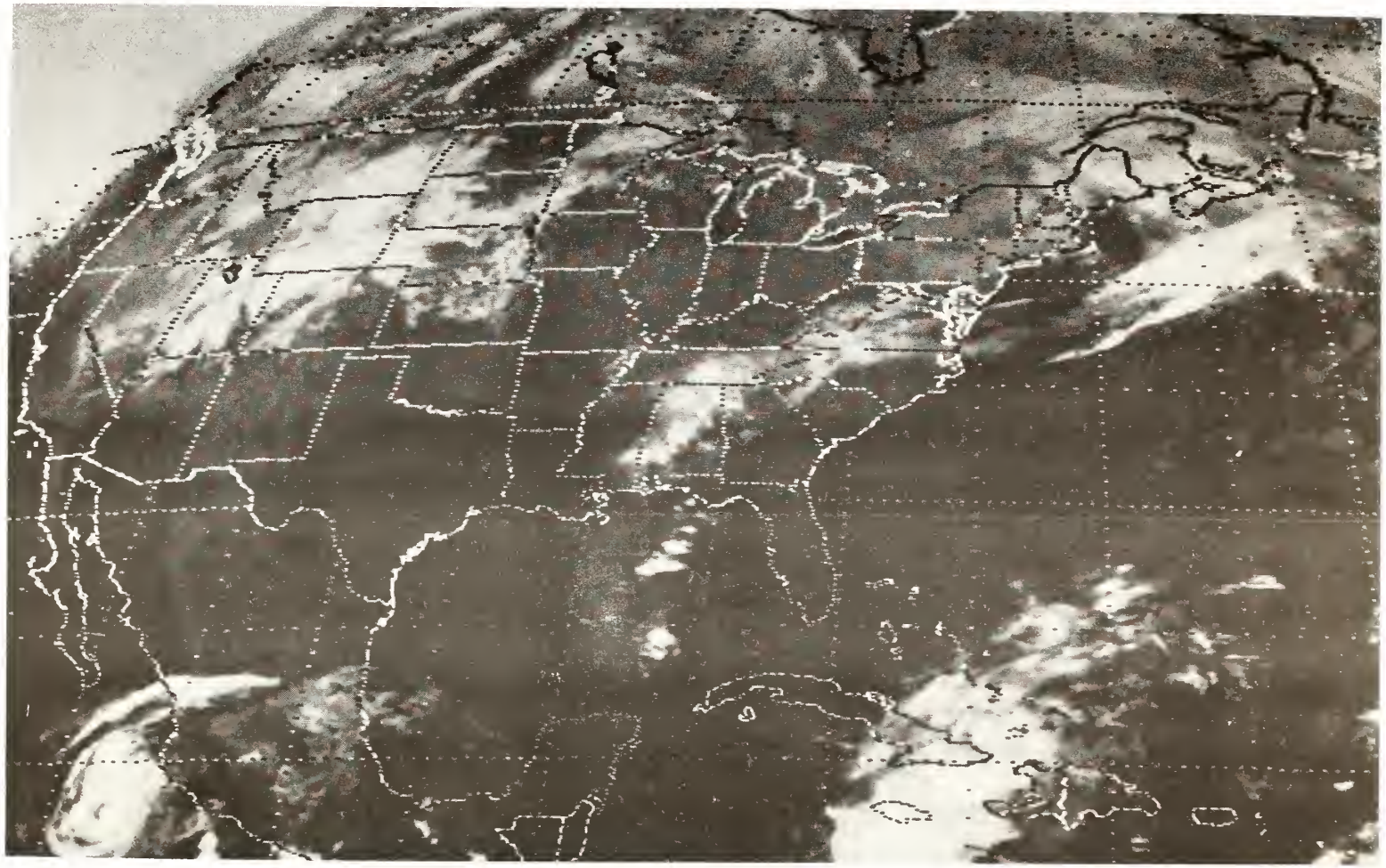


Figure 7. Daily Weather Picture

B. Polar-Orbiting Satellites

1. Stretched, Gridded Pass-by-Pass images.

Description. The individual swaths shown in figure 8 are produced after each satellite pass. These swaths provide complete coverage from pole to pole. Pass-to-pass contiguity is achieved by lateral east-to-west overlapping of the images. The process begins with the digitizing of the raw image signal. From there, the response values are adjusted by use of a concurrent voltage wedge. The voltage-to-count normalized responses are then adjusted ("stretch") to remove scene foreshortening near the horizons. This is accomplished through differential sample replication; the result is an equal area image. Latitude/longitude gridlines and coastal outlines are automatically melded with the image prior to display.

The polar-orbiting satellite follows a path shown in figure 9. From these tracks, 14 to 15 stretched gridded strips (computer produced grids fitting 1:1 aspect ratio data) are made using visible data and when tropical storm coverage is needed, selected infrared nighttime data are produced.

The photographic image produced is a set of three panels of 4km resolution, each 11.2 by 33.5 cm, which can be joined together to produce a continuous pole-to-pole strip. A legend appears at the top of the first two strips and the bottom of the third strip, containing satellite name; data type (day VIS or night IR); track number; orbit number; month, day, year of pass; time (hours/minutes/seconds) in GMT of the scan at legend position; and a "gray wedge" displaying the variation of white to black shown with appropriate "count value" limits.

Stretched gridded strips provide users with a "quick look" and a view of the scene in the perspective and spatial resolution of the original signals. The data in the visible part of the spectrum are used for general meteorological applications such as the determination of cloud coverage, cloud types, and systematic patterns of cloudiness. The information may be used separately or together with conventional weather data to determine the structure and behavior of specific circulation systems.

Over data-sparse regions, the satellite data are used as a substitute for conventional data. Models have been developed to relate the structure and patterns of clouds to conventional data. By using these relationships, bogus wind and density data can be inferred for use in standard analysis or in numeral forecasting models.

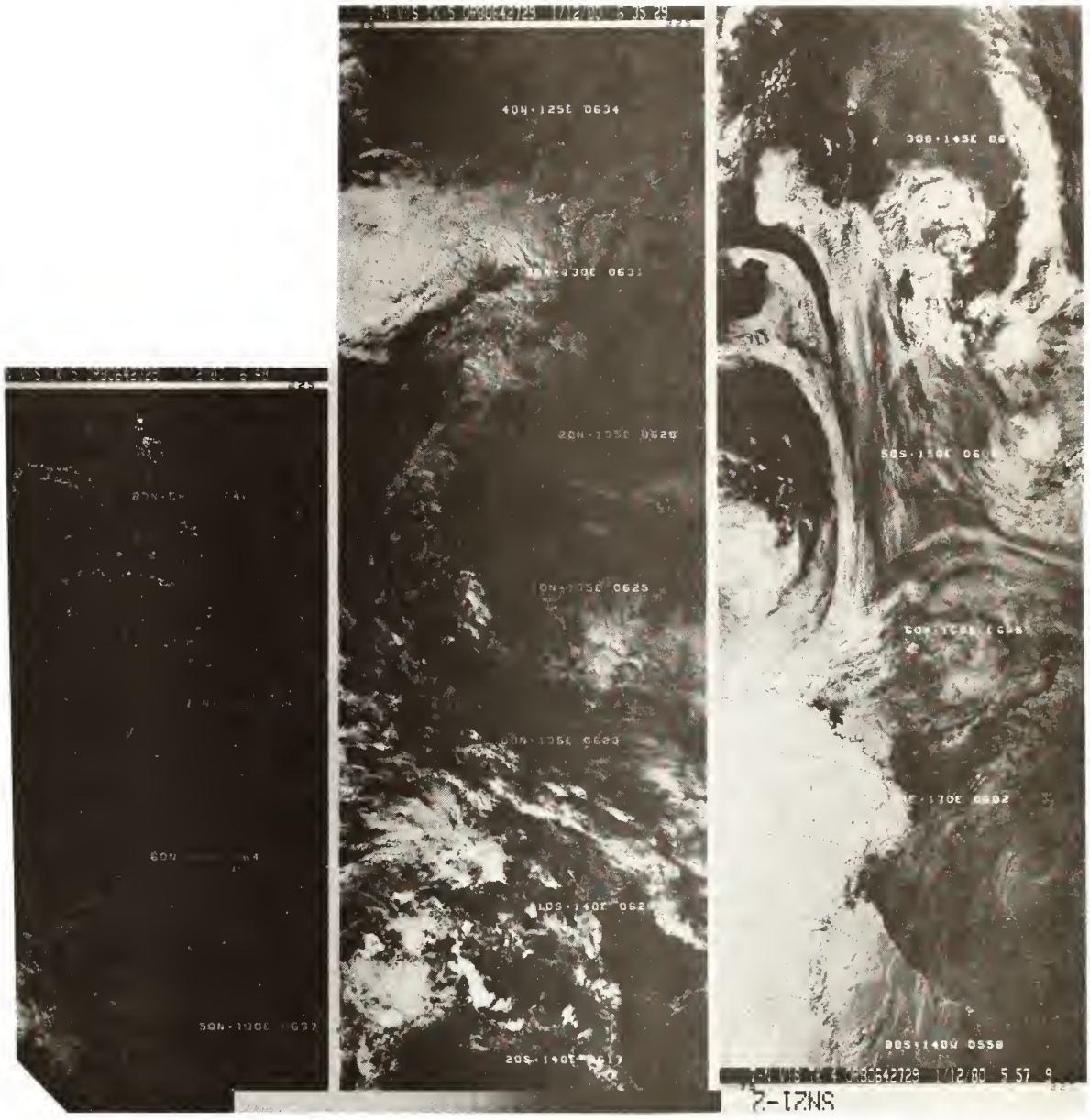
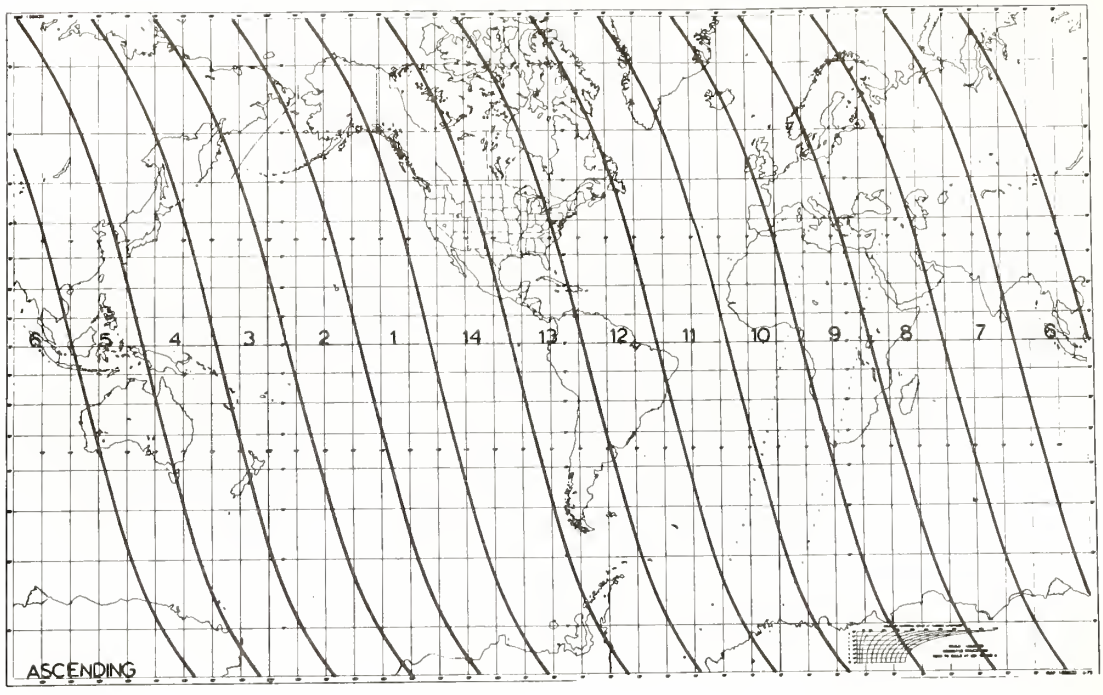


Figure 8. Stretched-gridded and unrectified pass-by-pass image



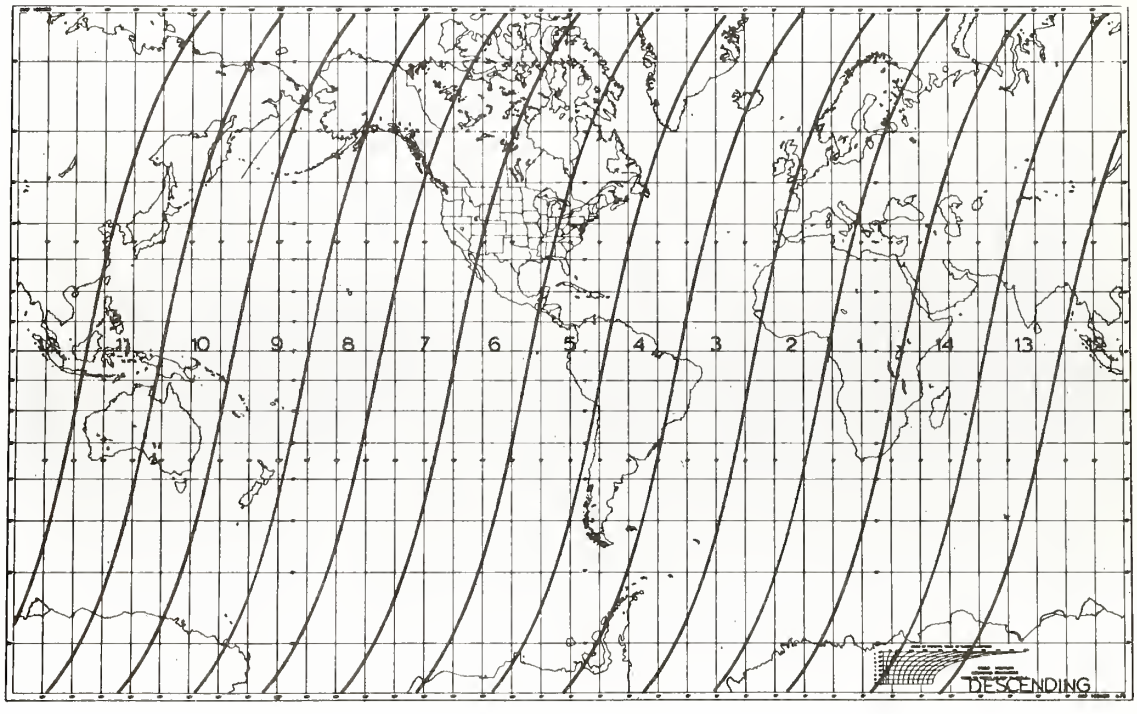


Figure 9. Tracks of polar-orbiting satellite's subsatellite point

The picture may be used in sequence to observe changes of weather patterns at the synoptic or larger scales. Data are also time-composited for climatological and hydrological uses.

Nighttime infrared data are used to determine the approximate temperatures of the emitting surfaces. From these, the type of surface observed can be distinguished, and the heights of cloud tops can be estimated. Although visible data are not obtained at night, the cloud-top information may be used to aid in the interpretation of visible data from the nearest daylight observation. The night IR data also are used along for general meteorological interpretation of cloud coverage, type, and pattern.

Primary users. The stretched gridded strips are used internally by NESS and by NWS and DOD. The original data used to produce the gridded strips are archived by the SDSD of NCC.

2. Hemispheric Polar-Stereographic Mosaics

Description. From a combined 24-hour set of AVHRR Global Area Coverage (GAC) data observed by the polar-orbiting satellite, six polar-stereographic mosaics are made--Northern and Southern Hemisphere: VIS (figure 10), IR day (figure 11) and IR night with a resolution of 15km at the equator and 30km at the poles. These photographic displays are produced at about 04Z for daytime and nighttime observations.

The process involves the accumulation of data on a disk in a 1,024-by-1,024, 8-byte, polar array for each hemisphere. The array is alined so it represents a subdivision of the Numerical Weather Prediction (NWP) grid system. Visible channel signals are brightness normalized to reduce the effect of varying solar illumination angles. The infrared signals are corrected for limb darkening (atmospheric absorption) caused by viewing at various angles.

A legend appears at the top of each display providing the satellite name; name of display (N.H. or S.H.; VIS, IR day, or IR night); date (month/day/year), and beginning and ending times of data displayed. The time passage of the satellite across the equator at six locations also is given on the display to help time-reference the data.

Above the legend are three gray-scale wedges. The top wedge includes the recorder device number and a machine-produced scale used to calibrate the film recorder equipment. The middle scale is a data gray scale that depicts the range of the data. The bottom scale is also a data gray scale but in linear form.

In the upper right corner of each infrared mosaic appears a box depicting the gross quantitative relation between gray tone and temperature in degrees Celsius. To accommodate the different temperature ranges that occur in tropical, temperate, and polar zones, a particular temperature range is represented in the box by gray tones that vary with latitude. By taking into account the cooler temperatures of higher latitudes, the scaling is arranged so only clouds will appear white or nearly white.

The applications of the daytime visual channel data and nighttime infrared data are the same as described in the Stretched, Gridded Pass-by-Pass Images Section. Daytime infrared data are used to determine relative cloud-top heights as a function of the temperatures derived from these data. A major application is to supplement visible satellite data by relating the cloud-top heights to other characteristics in distinguishing cloud type and structure. However, when no visible data are available, the IR data may be used alone for general meteorological interpretation.

Primary users. Hemispheric polar-stereographic mosaics are used by NESS, ERL, and DOD, and are archived by the SDSD of NCC.

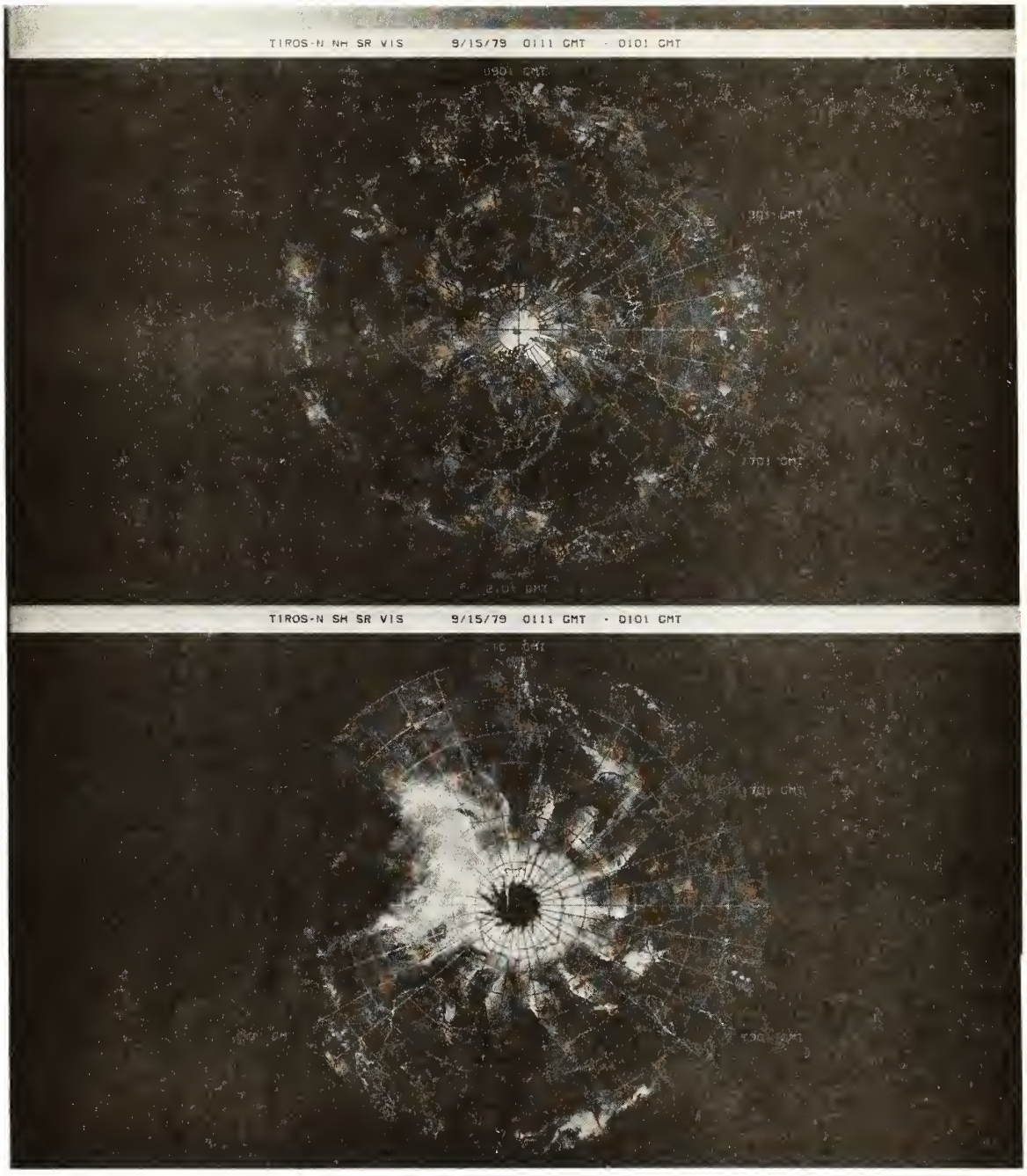


Figure 10. Hemispheric Polar-Stereographic Mosaic (Northern and Southern Hemisphere Visible Data)

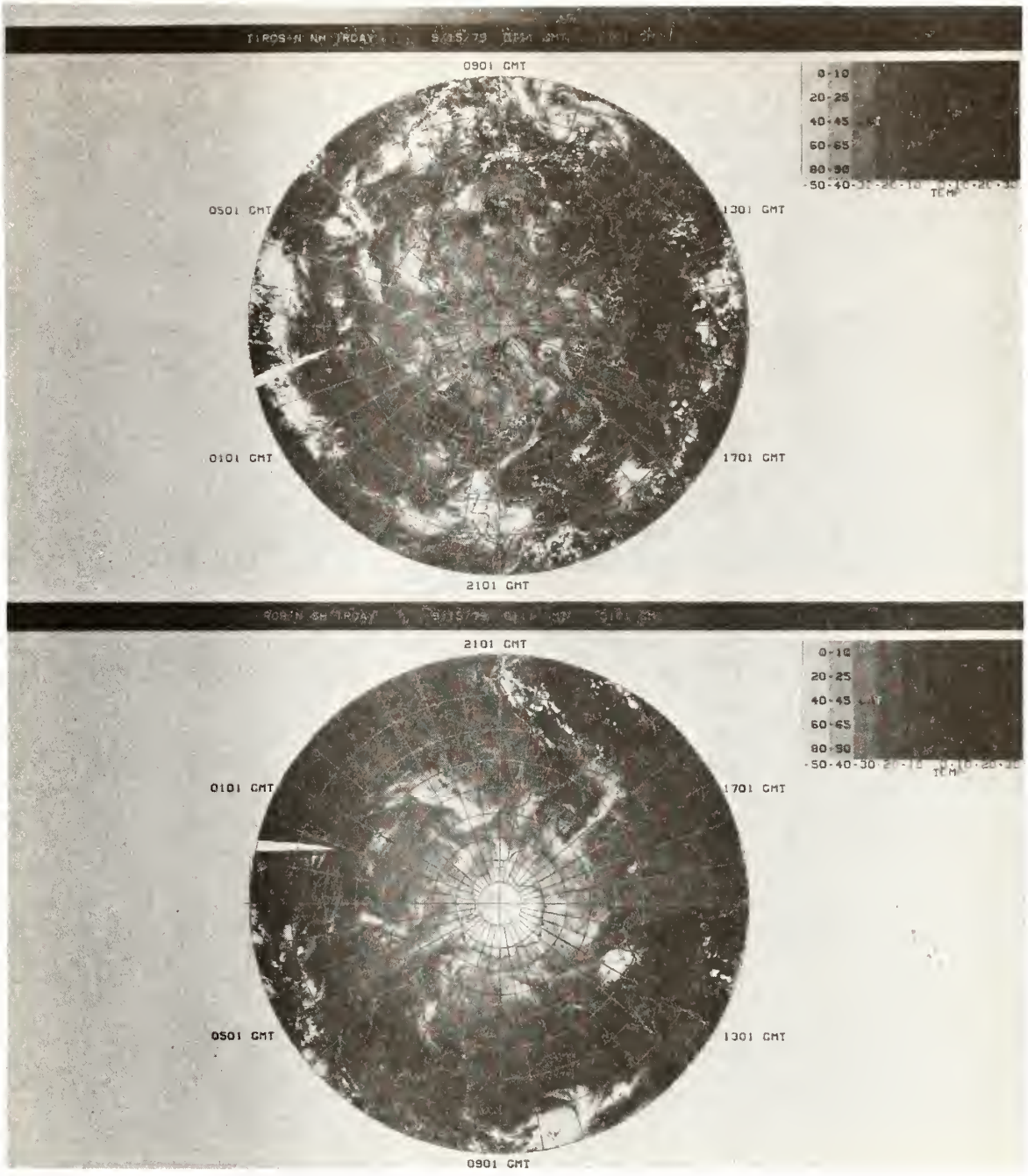


Figure 11. Hemispheric Polar-Stereographic Mosaic (Northern and Southern Hemisphere Infrared-Daytime Data)

3. Polar-Stereographic Quadrant Mosaics

Description. The polar-stereographic quadrant mosaics (figure 12) are AVHRR Global Area Coverage (GAC) displays of one-quarter of a hemisphere made up of up to four passes of the polar-orbiting satellite per quadrant with a resolution of 15km at the equator and 30km at the pole. Three types of displays are made for each hemisphere: VIS, IR day and IR night available to users at about 01½, 05½, 13½ and 17½.

The computer software and data base used to produce this product are the same as those mentioned for Hemispheric Polar-Stereographic Mosaics.

The legend that appears at the top of each quadrant provides the date of processing (month/day/year), satellite name, view number (1-8), hemisphere, type of data, longitudinal coverage, date of data and beginning and end time of coverage.

Polar-stereographic quadrants serve the same purpose as that described under Stretched, Gridded Pass-by-Pass Images and Hemispheric Polar-Stereographic Mosaics. These displays are enlargements of the hemispheric mosaics, covering up to four passes. This makes them more useful for positioning of synoptic patterns, determination of cloud coverage, etc., for the user interested in the macro-meteorological scale.

Primary Users. This product is used by NESS, NWS and DOD.

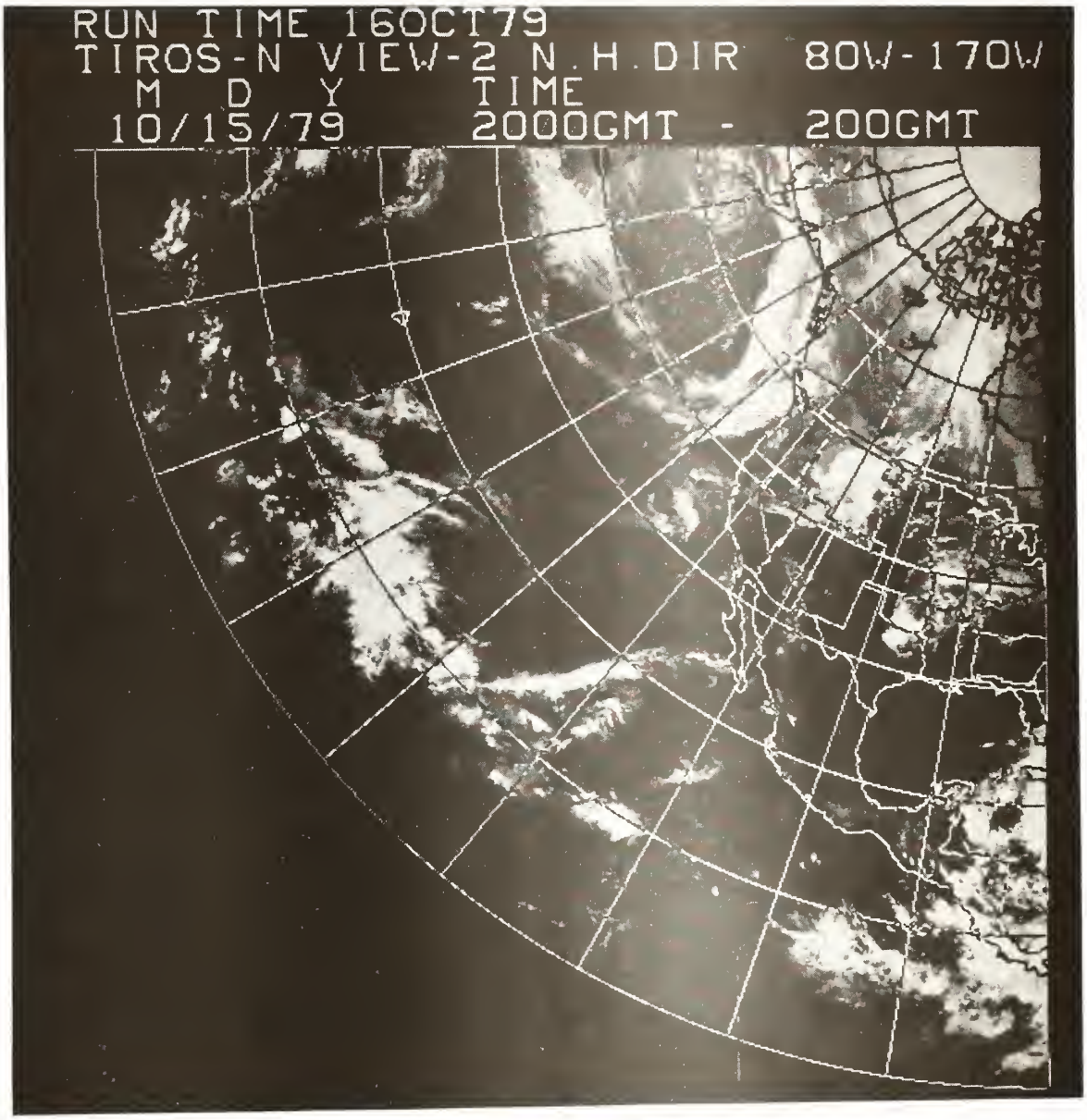


Figure 12. Polar-Stereographic Quadrant Mosaic

4. Mercator Mosaics

Description. The Mercator mosaics are made from 24 hours of stored AVHRR Global Area Coverage (GAC) observations as viewed from the polar-orbiting satellite. These mosaics cover from 40°S to 40°N latitude comprising the total 360° of longitude in two sections (figures 13 and 14).

The computer software involved in producing the mosaics imposes a square mesh array (4,050 columns by 984 rows) on a Mercator projection scaled 11.25 map elements per degree of longitude at the equator. A resolution of 10km at the equator is achieved with this display increasing up to 8km at 40°N or S. The data are mapped in 8-bit (256 shades of gray) quantities, once per day, producing three displays: VIS, IR day and IR night available to users at about 04Z. Negatives of each display are archived at the SDSD.

The legend located at the bottom of each display gives the satellite name, date (month/day/year) and time of first and last pass.

Gray scales located at the top of each display are used to calibrate the film recorder equipment.

The applications of this product are the same as that mentioned under GAC Hemispheric Polar-Stereographic Mosaics and Stretched, Gridded Pass-by-Pass images.

Primary Users. These mapped mosaics are used by NESS, NWS, ERL and DOD and archived by the SDSD of NCC.

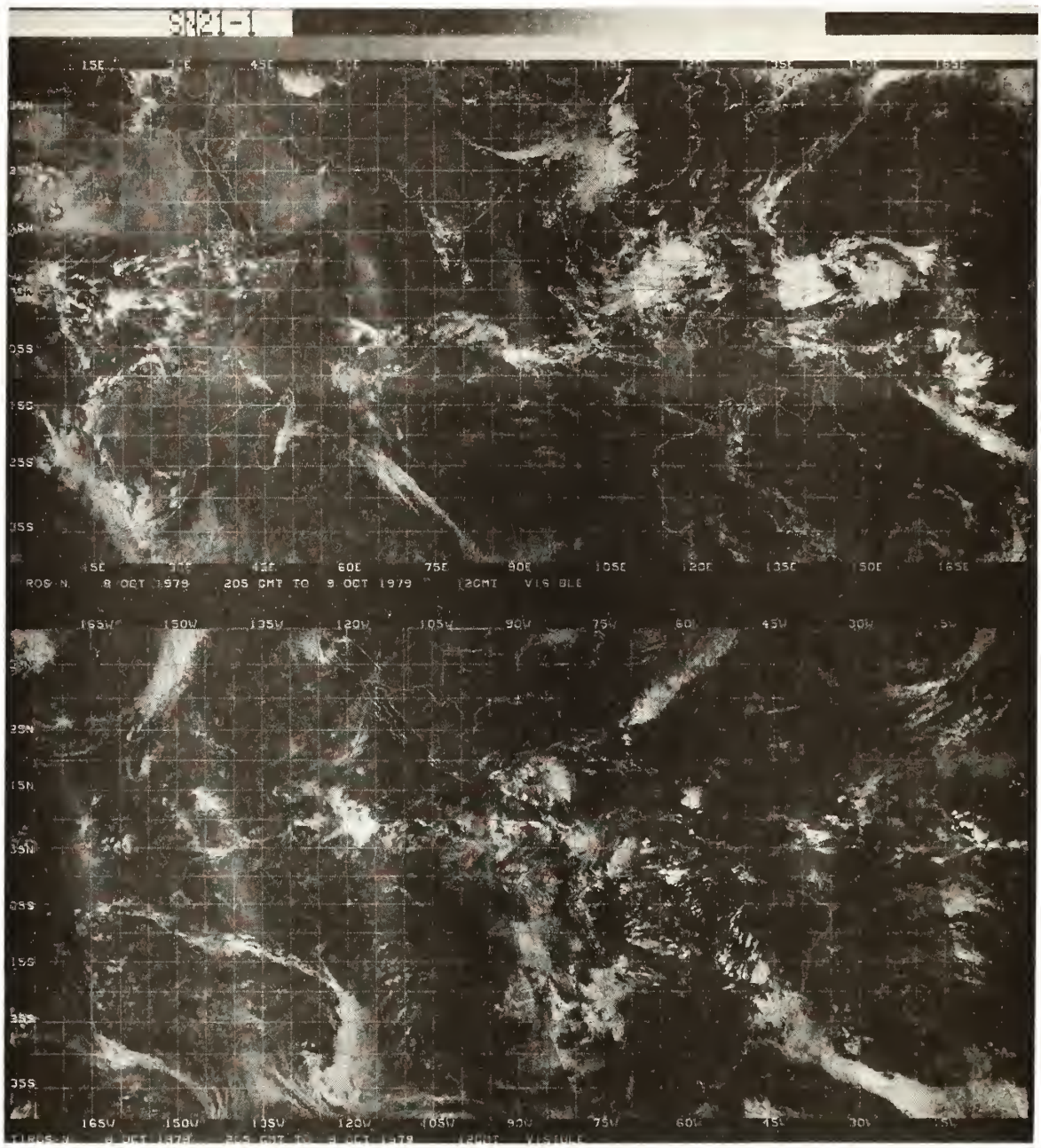


Figure 13. Mercator Mosaic (Visible Data)

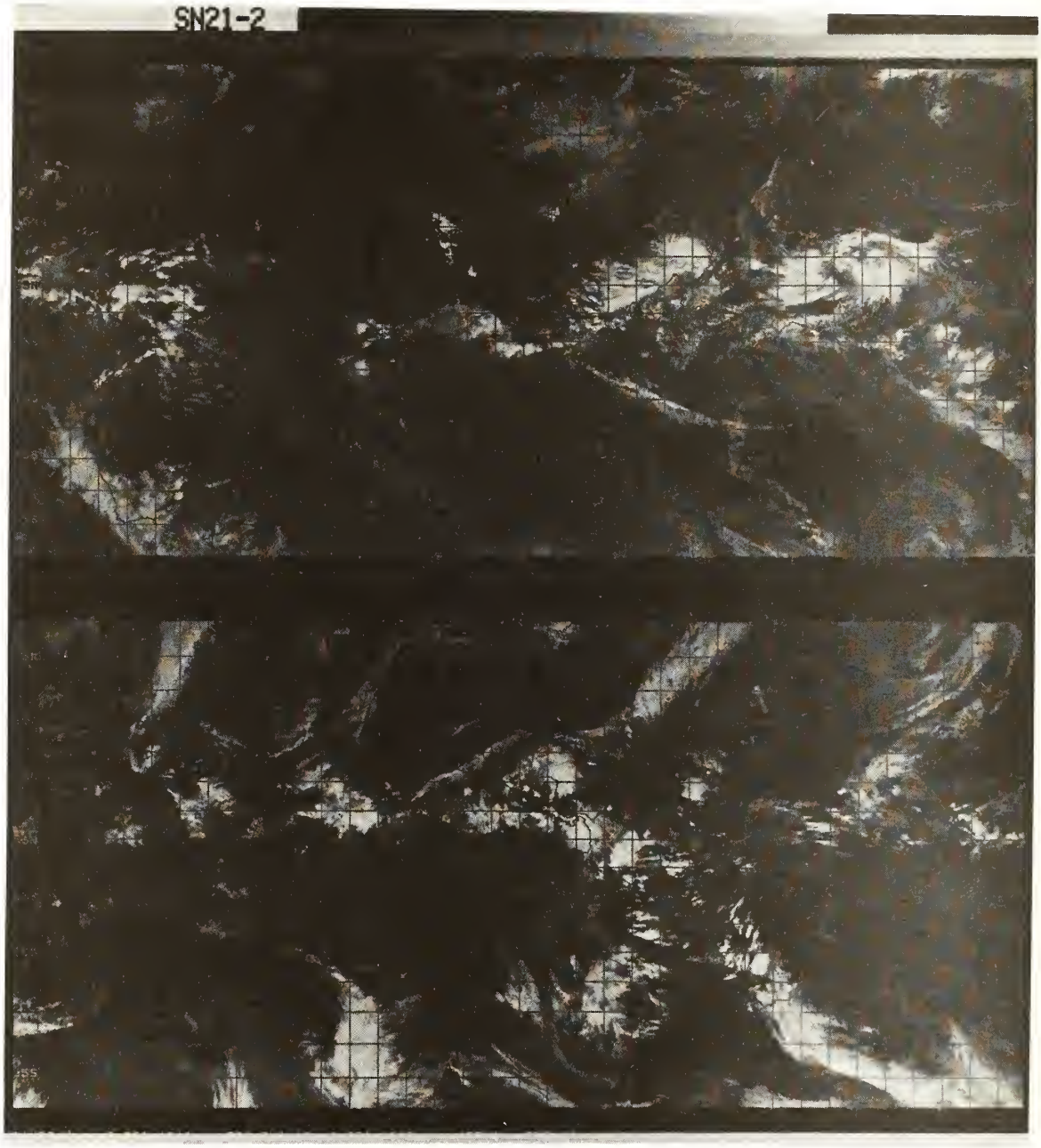


Figure 14. Mercator Mosaic (Day-IR Data)

5. Local Area Coverage Images

Description. The photographic display shown in figure 15 is produced from observations made by the Advanced Very High Resolution Radiometer (AVHRR) sensor on board the polar-orbiting satellite. The AVHRR senses in the visible and infrared spectrum with a resolution of about 1km at satellite subpoint (directly below satellite). High-resolution data collected by the satellite are either stored on board for later transmission as Local Area Coverage (LAC) data or broadcast directly to ground stations as a High Resolution Picture Transmission (HRPT). For a description of the picture transmission capabilities of the polar-orbiting satellite, see NOAA Direct Readout.

Operational recorder capacity is limited to 11.5 minutes of data covering roughly 40° of latitude during each orbit, with a possible 3 to 4 LAC recordings per revolution under special circumstances. Areas recorded are selected at the request of qualified users. Each recording can produce 1 3/4 images, one full image covering 1600km by 2400km. These displays are not stretched, gridded or rectified.

After the data have been received from the satellite, the Command and Data Acquisition (CDA) station transmits them to the Digital Data Handling Facility (DDHF) where magnetic tape records and Digital Muirhead Display (DMD), 25-by-25 cm, negative film transparencies are made. Negatives and digital AVHRR data received by NESS are archived by SDSD of NCC.

A legend appears at the bottom of the AVHRR image providing a machine-produced grayscale for calibration and, immediately below from left to right, the receiving station identification (e.g., San Francisco--SFO, Lanion--LAN, Gilmore--GIL, and Wallops--WAL), frame number, time of year (Julian date--ddd, hours--hh, minutes--mm, and seconds--ss) for first scan recorded, orbit (revolution) number (five digits), channel ID (1--VIS, 4--IR), and operator specified input parameters (24 characters).

The LAC images are very useful in the construction of Great Lakes and Coastal Ice Charts, Gulf Stream Wall Bulletins and Analyses, West Coast Thermal Front Analyses, Basin Snow Coverage Observations, Regional Snow Cover Analyses, Northern Hemispheric Snow and Ice Charts and for use in a variety of research work requiring high-resolution satellite data.

Primary users. This product has an extensive list of users inside and outside NESS, including NWS, ERL , National Marine Fisheries Service, NASA, DOD, Arctic Institute, universities, and many foreign research and weather agencies. An archive is kept by the SDSD of NCC.

Figure 15. AVHRR Local Area Coverage Image

6. Seven-Day Minimum Brightness Composite

Description. The purpose of the minimum brightness composite is to minimize the effects of cloudiness in satellite-acquired AVHRR data over polar regions. By saving only the minimum brightness response of each array location (1024-by-1024 array for each hemisphere) for a selected number of days, chart preparers can remove from that data set any relatively bright feature (clouds) that does not remain at one location for the 7-day period. The final product is a pair (VIS and IR) of polar-stereographic projection displays for each hemisphere (608 rows-by-608 columns S.H. and 1408 rows-by-1088 columns N.H.) recorded on tape and as a photographic image (figure 16).

The legend that appears at the top of each hemisphere display provides the type of data (VIS or IR), hemisphere, and beginning and end date (month/day/year), and times (GMT) of the composite. A gray scale appears at the top of the print for film recorder calibration.

Seven-day composites are produced daily for the Northern and Southern Hemispheres with the latest 24 hours added to the data set and the oldest 24 hours deleted. This product is combined with other products to aid in differing areas of research and analysis. In locating permanent snowfields and icefields, the 7-day composite aids in the preparation of the Northern Hemisphere Snow and Ice Chart. Comparing the composite with other photographic displays, the analyst is able to separate the snowfield and icefield background from clouds. The 7-day composite also is helpful in terrain studies.

Primary users. Two groups within NESS currently are using these data--Environmental Products Branch and the Synoptic Analysis Branch. These data are archived by SDSD of NCC.

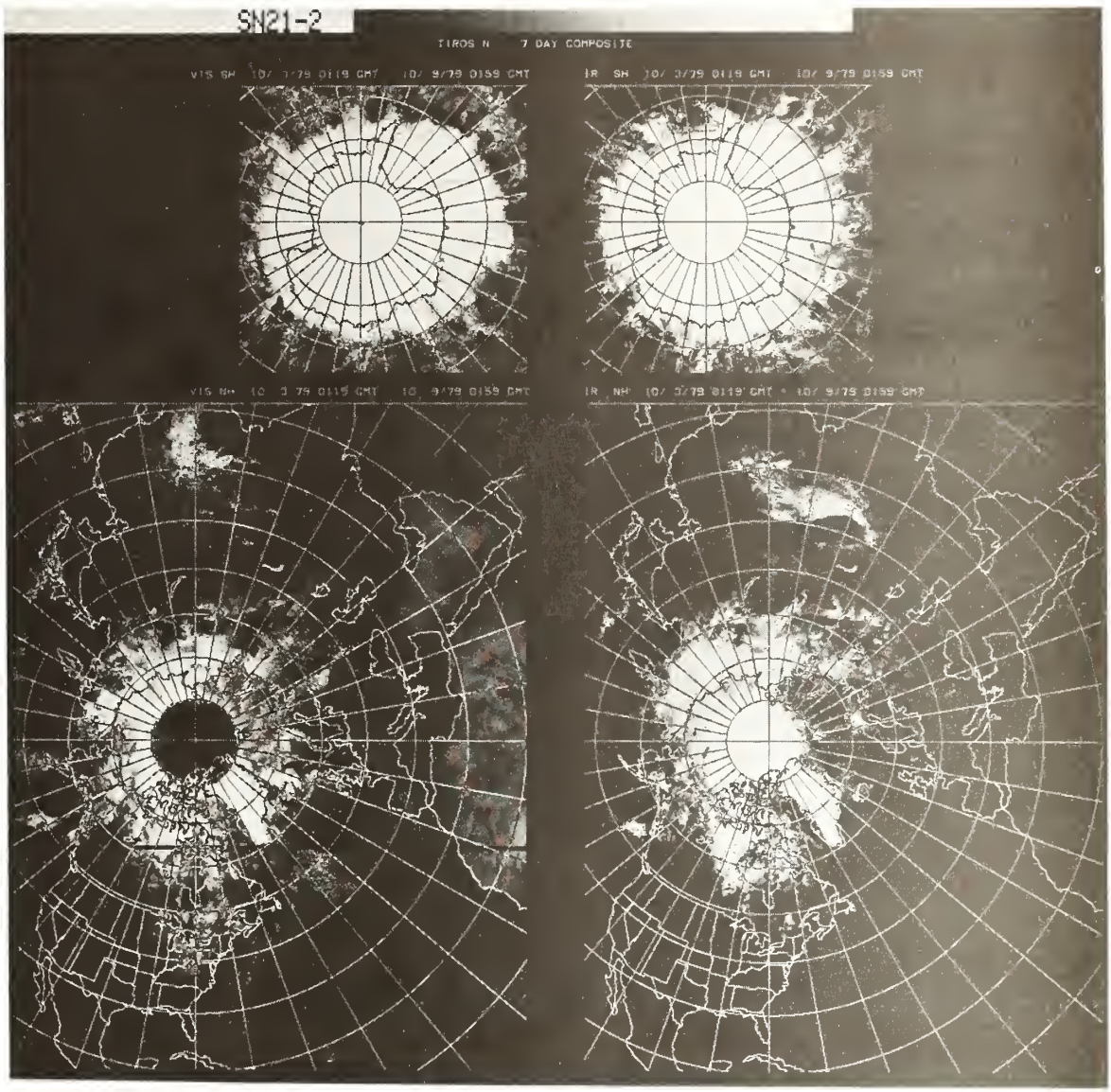


Figure 16. Seven-day Minimum Brightness Composite

II. IMAGE SERVICES

A. Geostationary Satellites

1. GOES Facsimile Displays Transmitted on Standard FAX Circuits

Description. The data received from the VISSR sensor on board the SMS/GOES series of geostationary satellites are used in the computer-derived production of gridded and unrectified facsimile displays (figure 17). These displays present the data in an unaltered form (unrectified) with an overlay of latitude and longitude lines and the outlines of land masses and U.S. State boundaries. The resolution of visible data is 4 by 4 km and infrared 4 by 8 km.

Each facsimile image contains a legend providing satellite name, type of data (visible--VIS, infrared--IR), resolution (miles), and date (month/day/year) and time (GMT) of observation. The transmissions are sent on standard facsimile circuits at a rate of 210 lines per minute in 16 shades of gray. A list of facsimile products, the areas covered, and their times of transmission can be obtained from

NOAA/NWS, W534
8060 13th Street
Gramax Building
Silver Spring, Md. 20910

Facsimile displays find their usefulness in the determination of cloud cover, cloud-top heights, and type, structure, patterns, and behavior of specific circulation systems. When periods occur in which other data sources become unavailable, facsimile images can be used as a substitute. With the collection of a series of images, local scene changes can be observed revealing small-scale motions, convective activity, and diurnal and differential heating effects.

Primary Users. Satellite facsimile displays are used by the NWS, Department of Defense (DOD), private meteorologists, universities, research concerns, and internally in NESS.

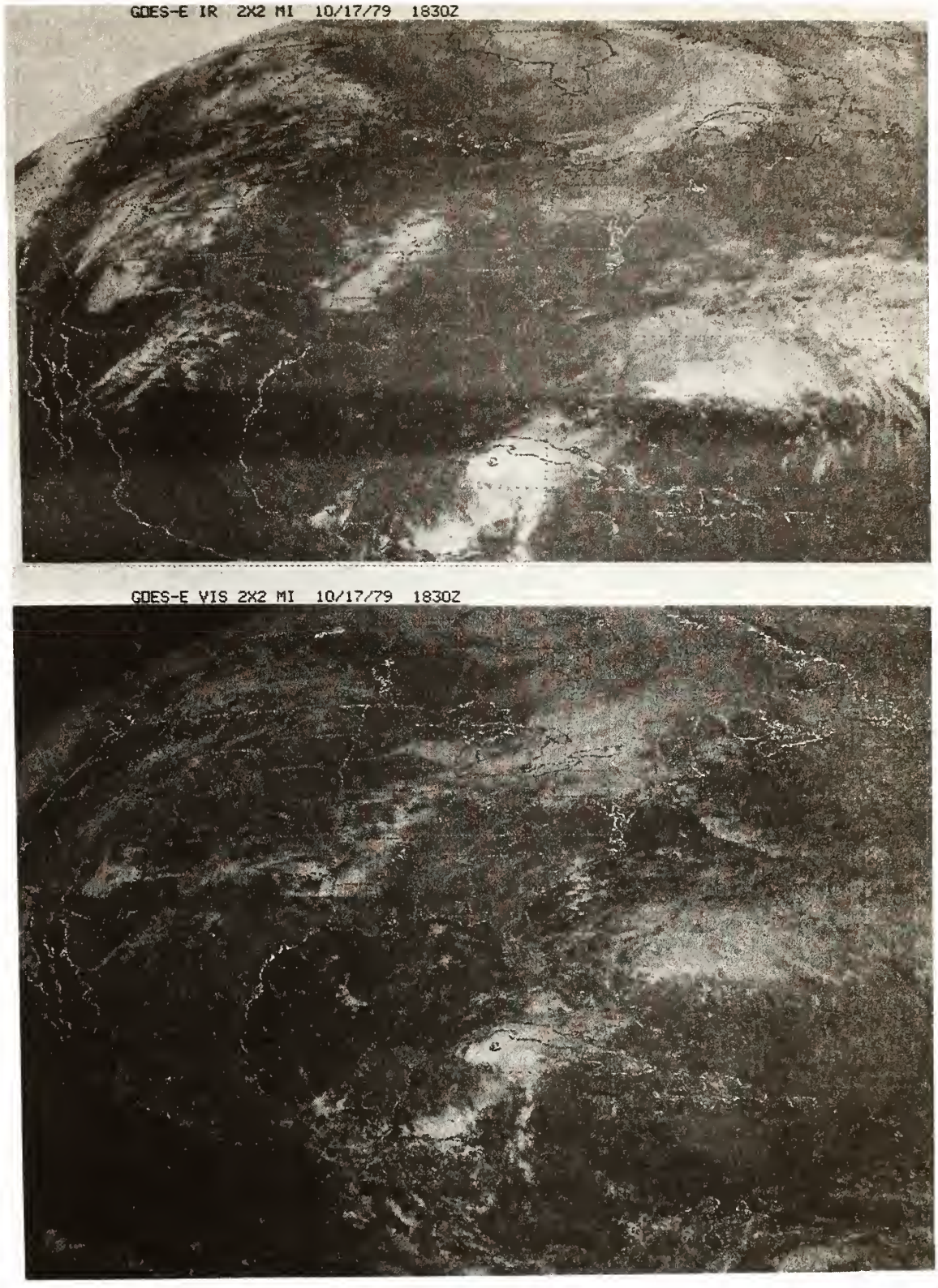


Figure 17. Gridded and Unrectified Facsimile Displays of SMS/GOES VISSR Data

2. GOES WEFAX

Description. A service known as Weather Facsimile (WEFAX) is available to any individual or organization with the proper S-band receiving and display equipment. The area of reception from the east and west geostationary satellites is shown in figure 1. Both mapped AVHRR-GAC data from the polar-orbiting satellites and unmapped VISSR data from the SMS/GOES series geostationary satellites are processed in the NESS computer system and broadcast via the SMS/GOES satellites. The Mercator and polar-stereographic mapped AVHRR-GAC images (figures 18 and 19) and the unmapped VISSR images (figure 20) have a resolution of approximately 8 km and, depending on the schedule, may contain infrared or visible imagery. Each broadcast contains two displays and each display contains a legend providing the source of data (satellite identification), date (month/day/year), time of coverage (GMT), geographic location, data type and, at times, a supplemental coded message. Updated schedules are transmitted when they occur. Also, during simultaneous VISSR/WEFAX operations, broadcasts are made at reduced uplink power in order to reduce the degradation of the VISSR data by WEFAX.

A third geostationary satellite, designated GOES-Central, also is used to provide WEFAX services. However, its mode of operation and products sent are sufficiently different than described here (see GOES-Central WEFAX).

Information on WEFAX ground receiving equipment and a list of WEFAX products and their time of transmission can be obtained from:

Coordinator, Direct Readout Services, S131
NOAA/National Environmental Satellite Service
Washington, D.C. 20233

Primary users. WEFAX services are utilized by foreign and domestic meteorological agencies, academic, commercial, and amateur station operators within receiving range of either GOES-East or GOES-West and having the proper S-band receiving equipment.

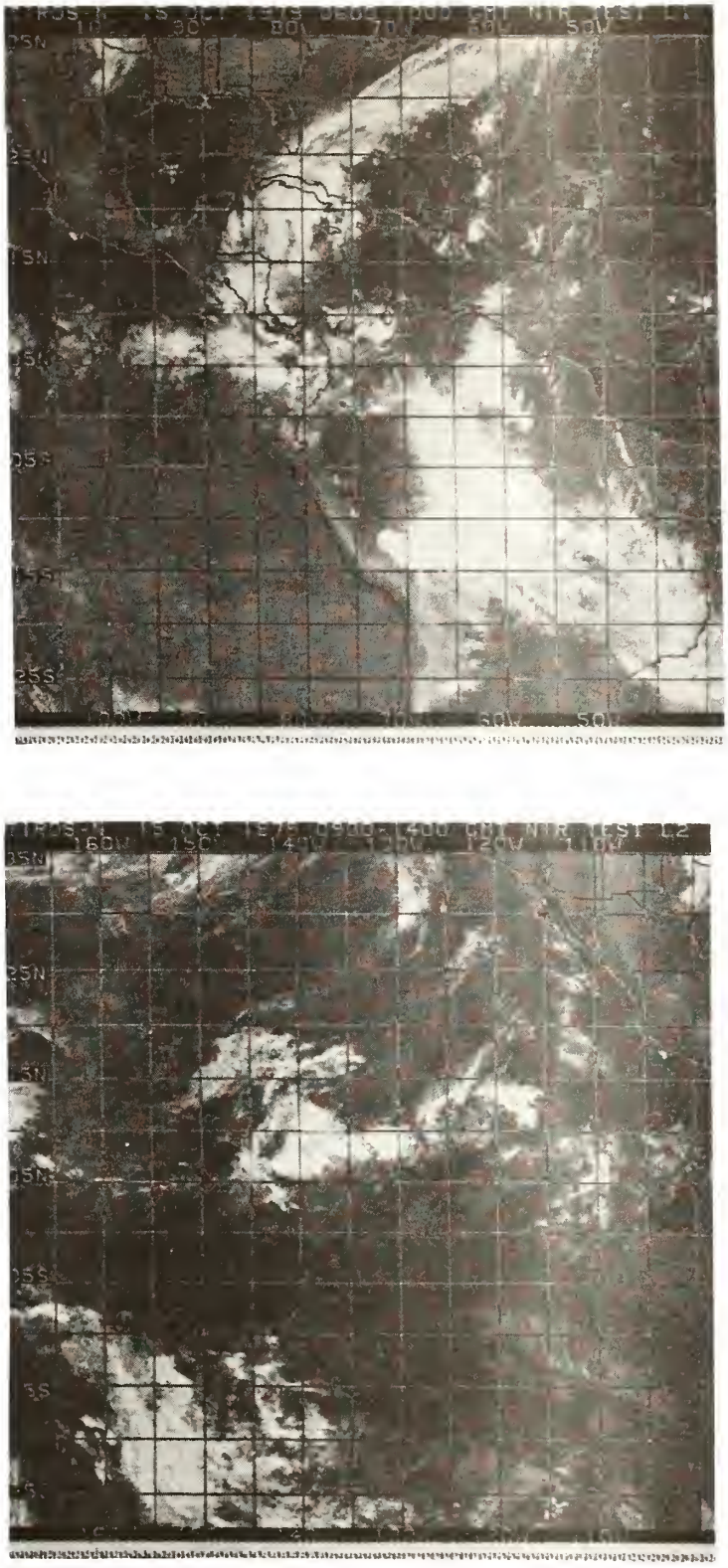


Figure 18. SMS/GOES WEFAX Mercator Mapped AVHRR-GAC Images

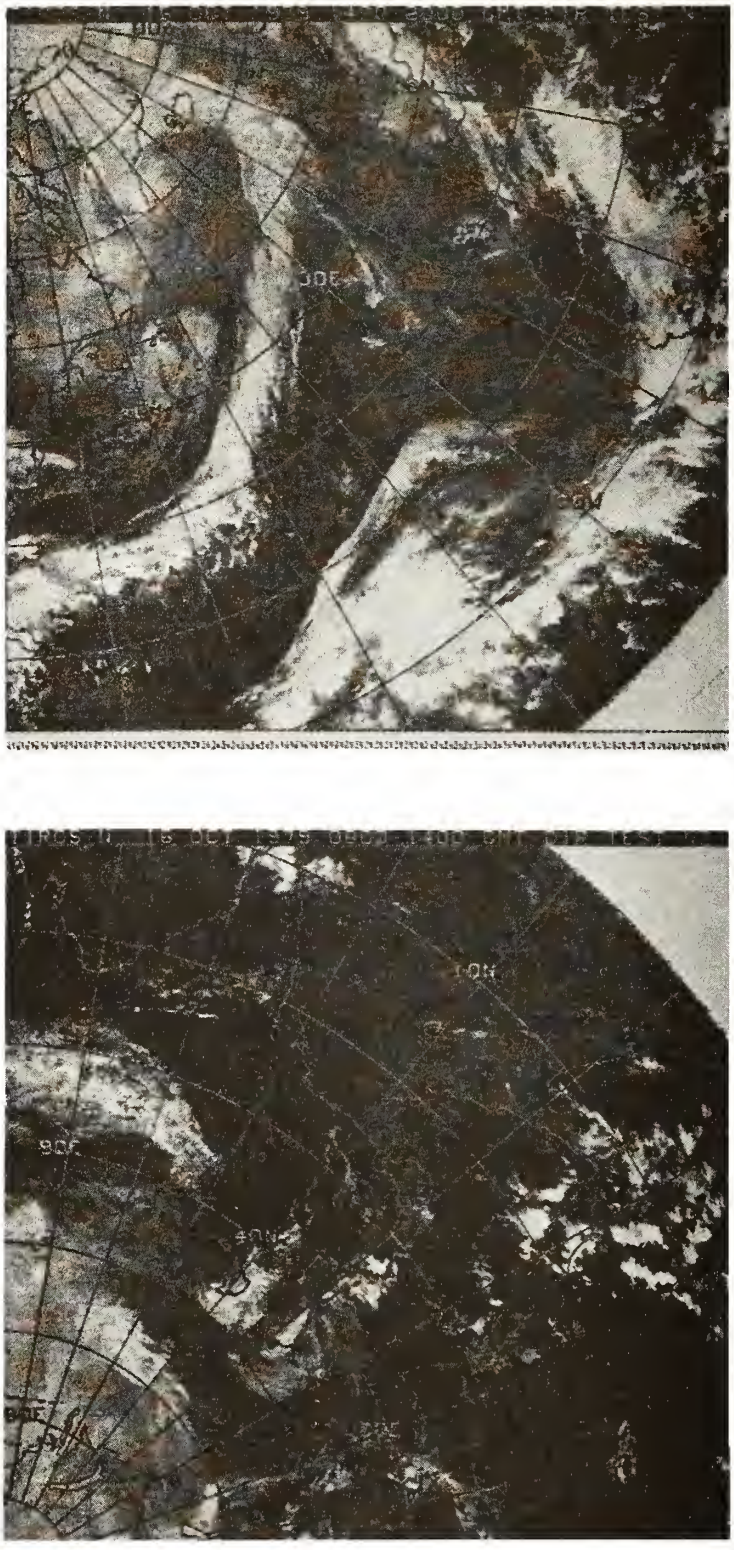


Figure 19. SMS/GOES WEFAX Polar-Stereographic Mapped AVHRR-GAC Images

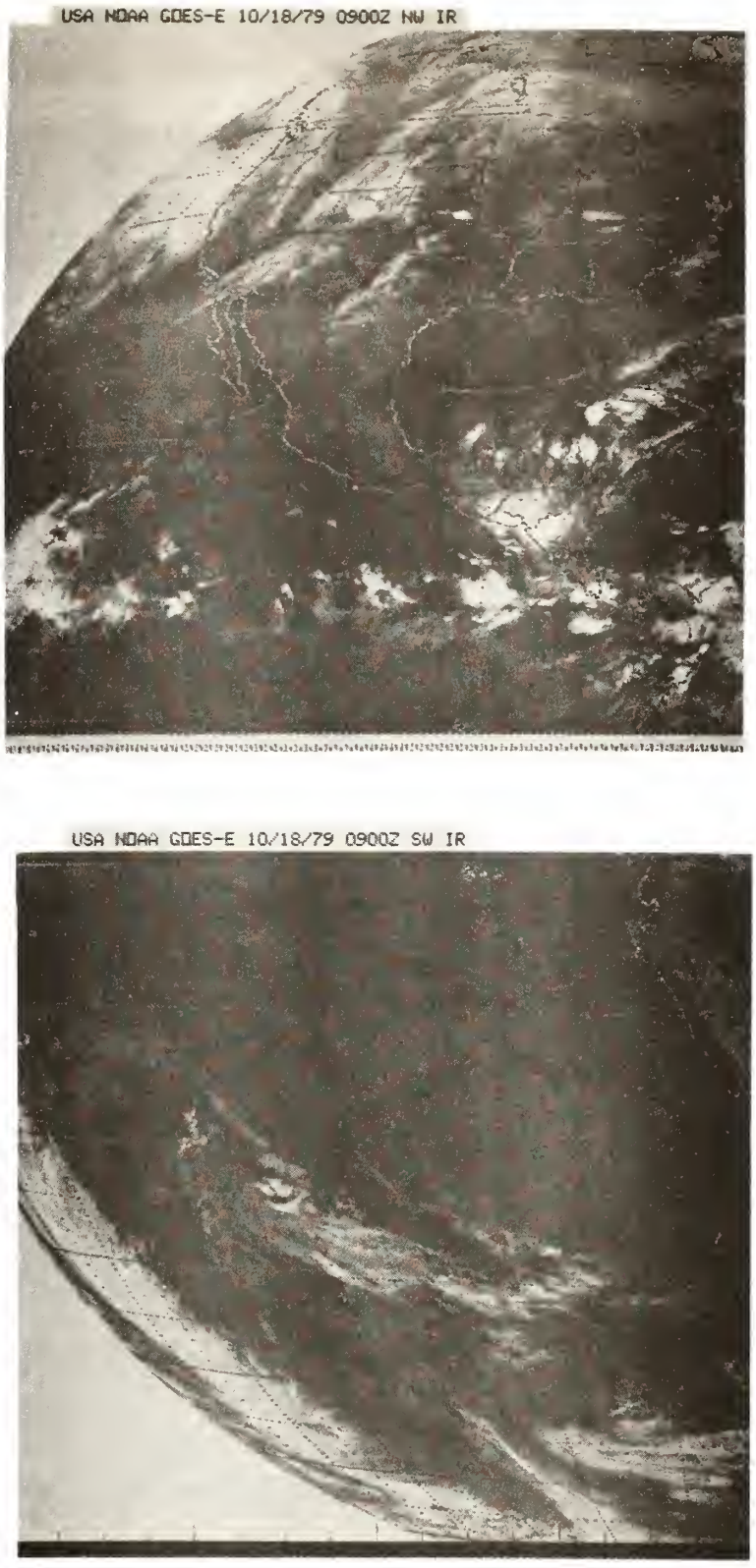


Figure 20. SMS/GOES WEFAX Unrectified VISSR Images

3. GOES Central WEFAX

Description. GOES spacecraft on which VISSR imaging systems have failed may be located at or near 105°W. This location, designated as the GOES-Central position, is currently occupied by GOES-2 which lost its imaging capability in early 1978.

GOES-Central spacecraft are used to provide WEFAX services similar to those provided through spacecraft located at the GOES-East and GOES-West positions. However, there are several unique aspects concerning both the service and the spacecraft.

First, there are no formal, long-term arrangements to maintain a spacecraft at the GOES-Central position. As long as there is a GOES in space with an inactive VISSR system, sufficient on-board fuel to relocate it, and resources to support its operation, a spacecraft will be located at the GOES-Central position and used to provide WEFAX services.

Second, all WEFAX broadcasts from this spacecraft will be at full uplink power since there would be no VISSR instrument to operate. Third, GOES-Central WEFAX products include both processed satellite imagery and selected National Meterological Center weather charts from the National Weather Service. Fourth, broadcasts are in large block times rather than in short segments. (Without an active VISSR, it is not necessary to alternate between VISSR imaging and WEFAX broadcasting.)

Equipment necessary to receive WEFAX broadcasts from GOES-Central is identical to that required to receive WEFAX data from other GOES spacecraft. (Reception range is the same as that for other GOES WEFAX broadcasts.)

Coordinator, Direct Readout Services, S131
NOAA/National Environmental Satellite Service
Washington, D.C. 20233

Primary Users. WEFAX services are utilized by foreign and domestic meteorological agencies, academic, commercial, and amateur station operators within receiving range of GOES-Central and having the proper S-band receiving equipment.

4. GOES Direct Readout

Description. The VISSR observations acquired by the SMS/GOES satellites can be received by ground stations in the areas shown in figure 1. With the installation of a ground station, users can receive near-continuous imagery at several resolutions, depending upon the mode of operation, 24 h each day (Rich and Popham 1975).

Persons interested in the construction of a VISSR direct readout receiving station should contact

Coordinator, Direct Readout Services, S131
NOAA/NESS, WWB
Washington, D.C. 20233

Primary users. Direct readout VISSR observations are used by foreign and domestic government agencies, universities, private consultant meteorological firms, research concerns, and amateur ground station operations.

5. GOES Tap

Description. A service known as GOES-Tap is available to users interested in receiving VISSR imagery transmitted to Satellite Field Service Stations (SFSS's) via landlines. Information on GOES-tap can be obtained from

Chief, SSD, S13
U.S. Department of Commerce
National Oceanic and Atmospheric Administration (NOAA)
National Environmental Satellite Service (NESS)
Washington, D.C. 20233

Primary users. The GOES-Tap service is used mainly domestically by private meteorologists, universities, government agencies, TV stations and commercial air lines.

B. Polar Orbiting Satellites

1. Tiros-N/NOAA Facsimile Displays

Description. The low resolution, Global Area Coverage (GAC) data received from the AVHRR sensor on board the polar-orbiting satellite are used in the computer-derived production of facsimile displays. These displays are in the form of mapped polar-stereographic and Mercator projections of 1:30M and 1:20 M respectively (figures 21 and 22). Labeling provides the location of latitude and longitude lines, the outlines of land masses, satellite name, time coverage (GMT), date (day/month/year), type of data (VIS, IR day, IR night), and NESS code name. The transmissions are sent on standard facsimile circuits at a rate of 120 lines per minute in 16 shades of gray. A list of facsimile products, the areas covered, and their time of transmission can be obtained from

NOAA/NWS, W534
8060 13th Street
Gramax Building
Silver Spring, Md. 20910

Facsimile displays find their usefulness in the determination of cloud cover, cloud-top heights, and type, structure, patterns, and behavior of specific circulation systems. When periods occur in which other data sources become unavailable, facsimile images can be used as a substitute. With the collection of a series of images, local scene changes can be observed revealing small-scale motions, convective activity, and diurnal and differential heating effects.

Primary users. Satellite facsimile displays are used by NWS, DOD, private meteorologists, universities, research concerns, and internally in NESS.

Figure 21. AVHRR GAC Mapped Polar-Stereographic Facsimile Display

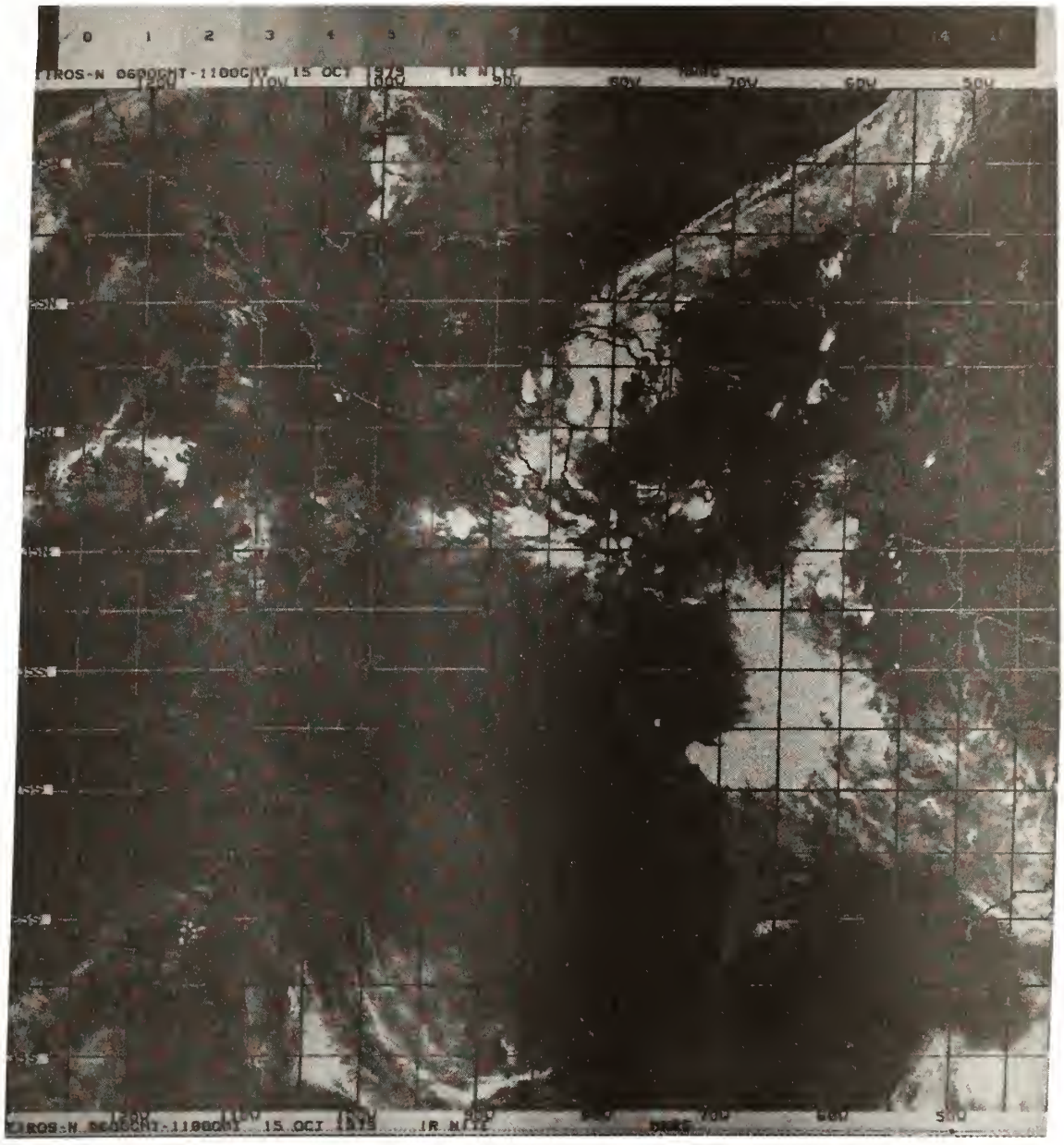


Figure 22. AVHRR GAC Mapped Mercator Facsimile Display

2. NOAA Direct Readout

Description. The NOAA polar-orbiting satellites continuously broadcast AVHRR, TOVS and SEM data to ground stations around the world. AVHRR data is provided both as a low resolution Automatic Picture Transmission (APT) and High Resolution Picture Transmission (HRPT). SEM and DCS are also included with the HRPT relays. Direct readout of TOVS data is a service known as Direct Sounder Broadcast (DSB). The APT signal is sent on VHF; the HRPT signal is an S-Band signal, while DSB's can be received on both VHF and S-Band. Stations receive from two to five or more broadcasts per day, depending on the latitude (the greater the amount, the higher the latitude) and capabilities of the receiving system. An example of a direct readout image is shown in figure 23.

NESS provides users with information on satellite tracking, data calibration, changes in transmitter status, and any other pertinent assistance that might affect the user's data reception. Requests for information on the planning, building, or modifying of a receiving station or on data utilization should be directed to

Coordinator, Direct Readout Services, S131
NOAA/National Environmental Satellite Service
Washington, D.C. 20233

Primary users. Direct readout data are used by foreign and domestic government agencies, universities, commercial organizations, research concerns, and amateur ground station operators.

Figure 23. Direct Readout Image received in Scotland, United Kingdom

III. METEOROLOGICAL PRODUCTS

A. Satellite Winds: Low-, Middle-, and High Level Cloud Motion Vector Field Messages

Description. The process used to determine cloud motion vectors from geostationary satellite data involves three main steps: movie-loop generation, computer derivation of low-level winds, and man-machine derivation of middle- and high-level winds.

The movie loop is a 16-mm film consisting of five land-registered photographic images representing 2 hours of real time, placed on a continuous loop with each image repeated twice and each beginning and end image repeated 20 times. The movie loop can then be projected on a digitizing board for the acquisition of beginning and end positions of clouds, thus obtaining cloud-motion vectors.

The low-level wind vectors are computer derived by ingesting four photographic images 30 min. apart, selecting the best two images through a quality-control sequence, land-registering the images, cloud-target selecting at preselected offset 2.5° latitude/longitude locations, and wind-vector editing by comparison with the 850-mb analysis. This fully automated process produces the low-level vectors that are put through a final quality check by the meteorologist/analyst.

The middle- and high-level winds are derived through the use of the Man/Machine Interactive Processing System (MMIPS) (Bristor 1975). First, the movie loop is viewed by the meteorologist/analyst, cloud targets are chosen, and beginning and end positions are recorded. Next, the cloud targets are viewed on the MMIPS cathode ray tube (CRT), and temperatures are determined for each target chosen. The computer then compares cloud-target temperature and vertical temperature profiles from the latest NMC Global Analysis to obtain target heights and computes target velocity and direction of movement from the digitized movie-loop cloud-target movements. These data are put through a quality-control check with the 500- and 200-mb analyses.

The cloud-motion vector fields are produced at 00Z, 12Z, and 18Z and are then delivered to users by 03Z, 15Z and 21Z respectively. The derived data are ingested into the National Meteorological Center's numerical forecast models, sent to users via teletype (figure 24 and 25), are archived on computer tapes by the Satellite Data Services Division of NCC.

```
TWXNIO KWBC 011000
YYXX 01100 200//
222 00401 97/// 21541 16522
222 00501 98/// 21541 17529
222 00701 94/// 14681 35526
222 00805 4199/ 15681 01026 16681 09527 3938/ 21531 04520 21531 03030
          34/// 21531 01035
222 01301 82/// 21541 25566
222 01404 3945/ 22541 23530 22541 23542 5681/ 22541 24039 22541 25053
222 01505 0013/ 22541 19023 22541 19030 2445/ 21541 21031 21541 21019
          53/// 21541 24038
222 01706 7853/ 15681 32528 15681 32531 9977/ 15681 30527 15681 32526
          2602/ 15681 34030 15681 35035
222 01803 1885/ 16681 13019 15681 18033 92/// 15681 18528
222 02604 8776/ 24491 25035 24491 24535 9537/ 24491 24532 24471 30039
222 02707 7699/ 21531 24549 23481 25029 7150/ 25491 26052 25471 27044
          2201/ 24471 29535 23471 31039 27/// 14681 25544
222 23803 4743/ 20531 23559 20531 25059 22/// 14681 22539
222 03402 3382/ 17601 27037 24491 23562
222 03504 8600/ 37291 27563 23541 26535 5216/ 28431 27562 25471 24546
222 03605 5437/ 26491 19528 26451 23539 9665/ 27451 21041 34291 20548
          20/// 23541 23539
222 04402 1030/ 24491 21066 25491 20554
333 00101 3890/ 10010
333 00301 3390/ 07519
333 00401 0090/ 09516
333 01201 8890/ 04019
333 01303 5909/ 04522 3890/ 09515 0490/ 10511
333 01403 5090/ 06517 3390/ 09016 0090/ 12517
333 01502 1890/ 09017 8390/ 10016
333 01605 8390/ 11020 5590/ 08517 5090/ 12020 3390/ 08514 0090/ 09514
333 01701 5090/ 12031
333 02204 8890/ 33004 5590/ 04008 3890/ 03507 0590/ 05508
333 02307 4890/ 09510 5590/ 05012 5090/ 03508 3890/ 10011 3390/ 05011
          0590/ 12005 0090/ 01503
333 02404 8890/ 25503 5090/ 12503 0590/ 10015 0090/ 09509
```

Figure 24. Low-, Middle-, and High-Level Cloud Motion Vector Field Message

TELETYPE TRANSMISSION FORMAT

This is the current format (as of 7-1-77) used to transfer Satellite Winds by long line tape drive from the 360/195 computer to the 360/40 computer.

Each bulletin may have up to 90 reports. If more than 90 reports are available for an octant then a second bulletin is created. In accordance with the description of the heading TWXXi_1i_2, i_1 (=bulletin numbers) will be incremented while i_2 (=global octant) will remain the same as the first bulletin. Thus there are provisions for 810 (9x90) reports per octant.

Description of Abbreviated Heading:
(First line of bullein)

TWXXii KWBC YYGGgg

TW-Data Designator - Satellite Wind
XX-Geographical Designator
(a) XN - for northern hemisphere
(b) XS - for southern hemisphere
(c) XX - for unspecified area
ii-Number of bulletin (i_1i_2) where
(a) i_1 = bulletin number
(b) i_2 = global octant
KWBC-Location indicator of originating office
YY-Day of Month
GG-Hour of day
gg-Minute of hour

Notes:
1. Current geographical coverage in the north-south and east-west directions are: 49°N southward to 49°S latitude
20°W westward to 170°E longitude
Vectors that do not fall in these limits are ignored.
2. All vector locations are rounded off to the nearest whole degree.
3. Octant numbers for vectors that round up to 90 west or down to 180 west are changed to 1 in northern hemisphere and 5 in southern hemisphere; i.e., octant number is forced to either 1 or 5.
4. Section 1 of the SATOB Code form will be coded only once per bulletin. For wind data, only Section 1, 2, 3 will be used.
5. All wind vectors of Section 2, code form 222 type will be coded first. Maximum number of reports per line is 4.
6. All wind reports of Section 3, code form 333 type will be coded after completion of Section 2. Maximum number of reports per line is 5.
7. When there are no reports available for a given bulletin, the bulletin is transmitted with the charters "NIL" followed by an end of bulletin character.
8. Program accepts only octants 0, 1, 2, 5, 6, 7 as valid octants.

Figure 25. Key to Cloud Motion Vector Field Message

Accuracy. Neither the satellite winds nor the radiosonde observations can be used as an absolute standard; however, the radiosonde is the best tool we have in determining the atmospheric winds. Therefore, the derived satellite winds are compared with radiosonde observations to determine their accuracy (Bauer 1976, Hubert and Timchalk 1972, Hubert 1976, Novak and Young 1976, Poole et al. (1975) unpublished, Poole and Borneman (1975) unpublished, Young et al. 1972).

For upper cloud vectors, Hubert (1976) determined that 68% deviated 15 kt or less from radiosondes, whereas lower cloud vector deviations were approximately half that of upper level deviations. He also states that "the accuracy of most cloud vector winds is about the same as that of balloon observations, but a small portion (say about 15 percent) contains significantly larger errors."

Primary users. National Meteorological Center of the NWS, U.S. Air Force- Global Weather Center, U.S. Navy - Fleet Numerical Facility, twenty foreign countries and various research concerns.

B. Atmospheric Soundings

Description. A combined instrument system on board the polar orbiting satellite known as the TIROS Operational Vertical Sounder (TOVS) employs the MSU, SSU, and HIRS/2 sensors to provide global atmospheric soundings for operations at the National Weather Service (NWS) and other users around the world. The two polar-orbiting satellites operated by NESS provide some 16,800 soundings per day. A display of the density of observations for a given 24 hour period in the Northern Hemisphere is shown in figure 26. The sensor observations are transmitted to one of the three receiving stations, Gilmore Creek, Alaska, Wallops Island, Virginia, or Lannion, France, and retransmitted to the Digital Data Handling Facility (DDHR) at Suitland, Maryland, for computer generation of sounding products. The TOVS processing system (Modali and Novak 1979) converts the raw radiance retrievals of the three atmospheric sounders into operational products consisting of 1) Layer means temperatures for standard pressure levels 850 mb, 700 mb, etc., 2) Layer precipitable water amounts for the three layers of surface to 700 mb, 700-500 mb, and above 500 mb, and 3) Clear radiance values for the twenty HIRS/2 channels, four MSU channels and three SSU channels. These data are archived by the SDSD of NCC. NESS maintains these data on computer disk rotating files for input into current day products such as global sea surface temperature observations and weather analysis and forecast models. A portion of the sounding products are formatted into WMO code for transmission over the Global Telecommunications Service (GTS) network. Earth-located calibrated radiances are provided by agreement to the British Meteorological Office via a low data rate line from the DDHF.

Accuracy. The accuracy of satellite atmospheric soundings is checked by comparison with radiosonde data. Accuracies listed here are goals that NESS expects to achieve for these products. For mandatory pressure levels in the atmosphere, layer mean temperature accuracy goals are: surface to 850 mb: $\pm 2.5^{o}K$; 850 mb to tropopause: $\pm 2.25^{o}K$; tropopause to 2.0 mb: $\pm 3^{o}K$; and 2.0 mb to 0.5 mb: $\pm 3.5^{o}K$. Layer precipitable water accuracy goal is ±30%. Clear radiance goals are within ±2%.

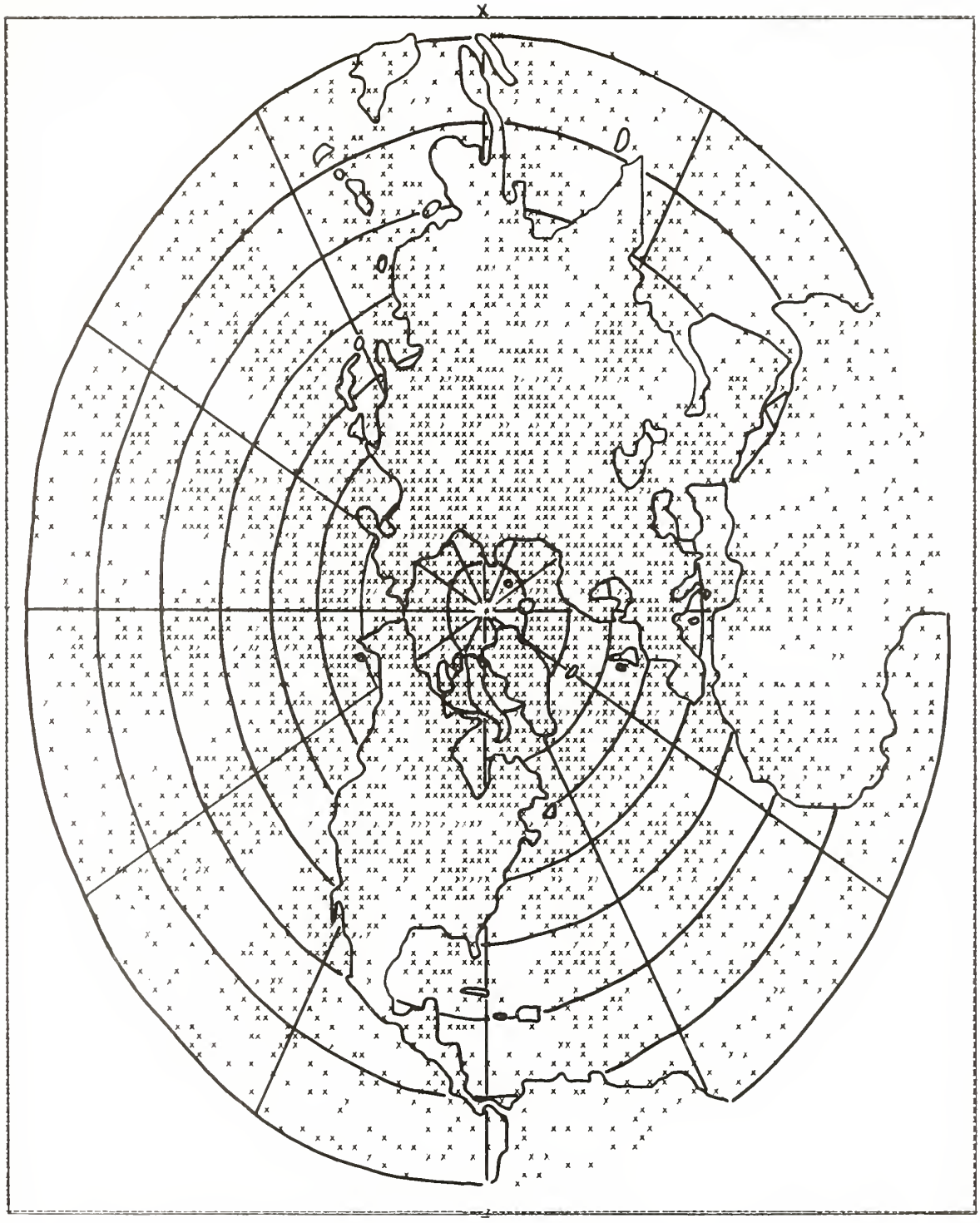


Figure 26. Atmospheric Soundings in the Northern Hemisphere for a Given 24 Hour Period

Primary users. Atmospheric sounding data is used internally at NESS, by the NWS, U.S. Navy, foreign weather operations, and various research concerns. An archive is kept by the SDSD of NCC.

C. Global Heat Budget

Description. The global heat budget as analyzed from the polar-orbiting satellite's AVHRR data is determined daily for both the day and night longwave flux and the absorbed and available solar radiation. Infrared and visible radiances, derived from averaging a 10-by-10 array of GAC (4km resolution data) representing a 50km square of viewed area, are combined with time, earth location and angular measurements of satellite and sun altitude as an initial data base for analysis. The heat budget parameters are then derived, daytime and nighttime longwave flux from 12 hours of infrared retrievals each and absorbed solar from the difference between the solar constant and the visible spectrum retrievals, and mapped into 2.5° arrays by correcting for viewing angle and earth curvature. Hemispheric (125-by-125 element) square arrays are then produced from a fit of the 2.5° fields, both data arrays being stored on a 37-day continuous disk archive. A monthly archive tape is produced from the disk data set for users and daily and monthly photographic displays of heat budget fields are generated for quality control.

The photographic display (figure 27) is a set of three sections: nighttime-flux, daytime-flux and absorbed solar. Each section displays a northern and a southern hemisphere polar-stereographic and Mercator representation of the heat budget fields on disk. A legend appears at the top of each section providing the display title, date (month/day/year), order of individual displays, average flux values (watts/meter^2) for each and the percentage of missing data.

The Global Heat Budget fields are of importance to long-range forecasting and climate research.

Accuracy. Global heat budget fields have an accuracy within ±7 watts/meter^2 for reflected and outgoing radiant energy. Spatial resolution, due to the nature of the data and its analysis, is approximately 100km.

Primary users. The Global Heat Budget fields are used within the originating group of NESS-the Atmospheric Energitics Branch, the Long Range Prediction Group of the NWS and an archive is kept by the SDSD of NCC.

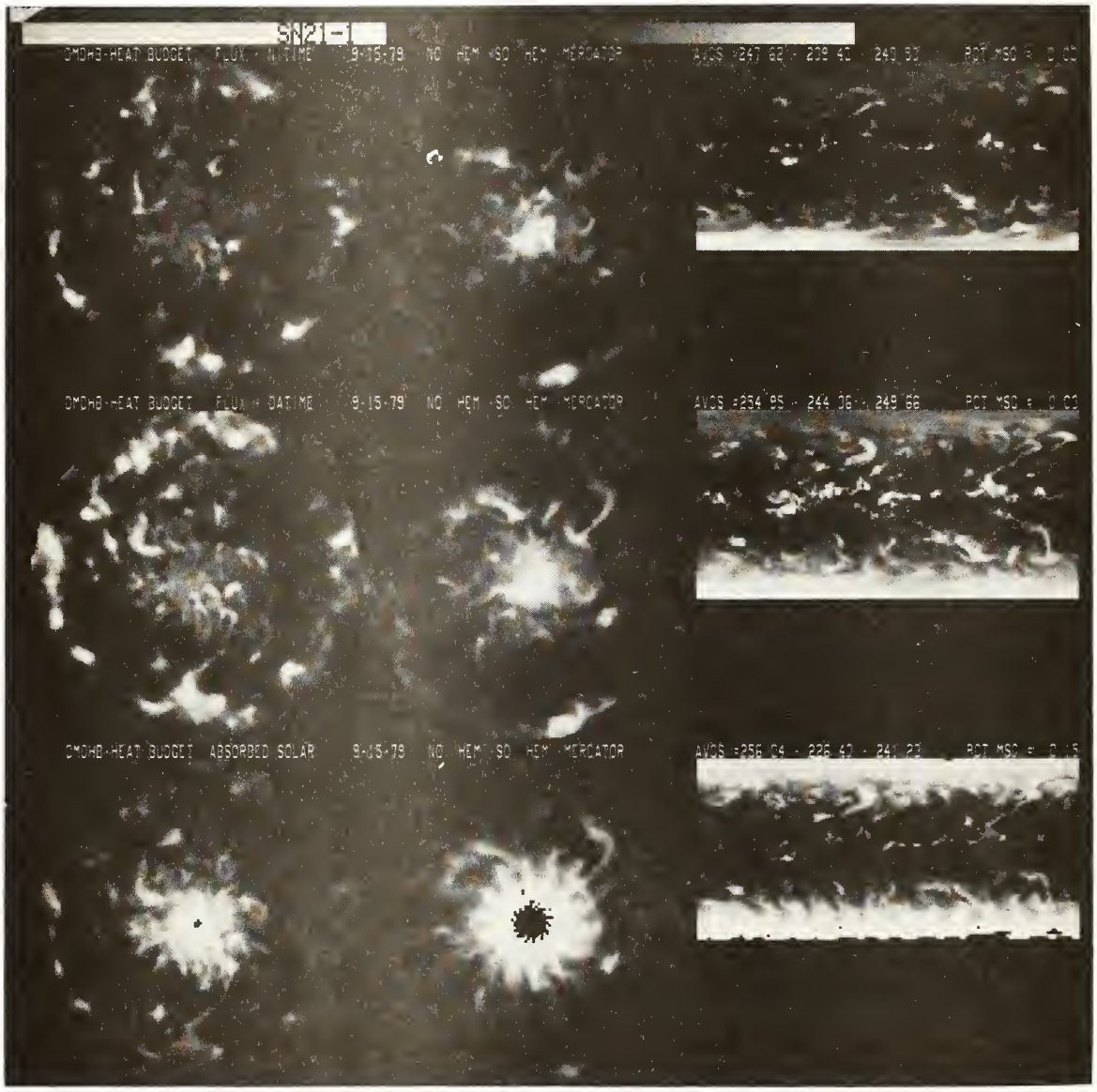

SN21-1
CMDHB-HEAT BUDGET FLUX - DAYTIME 9-15-79 NO HEM SO HEM MERCATOR
AVGS =247.62 - 239.40 240.53
CMDHB-HEAT BUDGET FLUX - DAYTIME 9-15-79 NO HEM SO HEM MERCATOR
AVGS =254.95 - 244.06 - 249.66
CMDHB-HEAT BUDGET ABSORBED SOLAR 9-15-79 NO HEM SO HEM MERCATOR
AVGS =256.04 - 226.42 - 241.23

Figure 27. Global Heat Budget Quality Control Image

D. Weather Summary and Bulletins

1. Satellite Interpretation Message

Description. The Satellite Interpretation Message (figure 28) is a general synopsis of the weather affecting the United States supplied two to eight times per day depending on the SFSS issuing office. The summary is sent out on weather teletype circuits to all users from the SIM issuing offices; Washington, D.C., Kansas City, MO, San Francisco, CA, Honolulu, HI, and Anchorage, AK.

Primary users. This product is received by most domestic weather operations.

ZCZC WBC835
TSXX6 KWBC 201400
DCA SFSS SIM BASED ON SMS 2 DATA THRU 1300Z

WKNG VORT MAX MOVG EWD 35KT ACRS UPR MI IS NOW JUST W OF SSM WITH ASSOCD TROF SEWD TO ERN LK ERIE. A SECOND SHRTWV LIES SWWD ACRS SRN LK MI.

ANOTHER SHRTWV MOVG EWD 40KT THRU THE DAKS TO INL MCW LN WITH ASSOCD CLDS DMSHG IN PAST SVRL HR.

PVA CONTS OVR AREA FM PA TO SC ALTHO VORT MAX I NO LONGER DISCERNIBLE AT THIS TIME.

CSTL WTRS WITHIN 200MI OF COST S OF 40N ... BKN/OVC CI MVG NWD ALG NJ CST AND OFSHR SWD TO HAT WITH PTCHY CI ALG DELMARVA TO HAT CST. BKM MID CLDS PUSHING OFF SC/GA COST. SCT LOW CLDS OVR RMDR.

MARINE AREA N OF 40N W OF 60W ... MULTILYRD CI S OF LN 40N69W 43N60W. BKN CI N OF THIS TO LN BOS 45N65W. RMDR CLR.

RMDR OF MARINE AREA W OF 40W BTWN 30N AND 45N ... LOW CNTR 32N68W. MULTILYRD OVC TO CI WITHIN AREA 30N66W 35N65W 37N67W 34N71W 37N72W 43N60W 40N50W 30N62W WITH CLD NS THINNING TO SE. EMBDD SCT CNVRTN TO 350 E OF LOW ALG FNTL BND S OF 35N BTWN 66W AND 63W MOVG ENE 20 KT.

FOR NYC INTL AVN INTERESTS ...CNVTN SCT OR LESS.

END
COOKE

Figure 28. Satellite Interpretation Message

2. Satellite Weather Bulletin

Description. Satellite Weather Bulletins are coded messages describing past (12 and 24 h previous) and present location, movement, intensity (using Dvorak Tropical Disturbance Classifications), and general cloud characteristics of tropical cyclones. Meteorologists routinely analyze and interpret polar-orbiting and geostationary satellite data images over all ocean areas for potential and existing tropical disturbances and prepare bulletins to be sent out as needed via teletype (figure 29). The bulletins are useful in alerting foreign weather operations to significant tropical weather due to the lack of conventional weather observations over the oceans.

Accuracy. The accuracy in location and movement is dependent on the resolution of the satellite imagery used. Position location is given to the nearest tenth of a degree.

Primary users. The product is used by foreign weather operations.

SATELLITE WEATHER BULLETIN

NOAA-4 VIS/IRDAY WEST PACIFIC
RUBY
01 JULY 1976 0022Z
23N 126.1E T5.5/5.5/DO.5/24HRS

PAST POSITIONS: E21.2N 124E 301209Z IRNITE
21.1N 122.9E 300123Z VIS/IRDAY

CENTER DEFINED BY ROUND DISTINCT EYE APPROX ONE-THIRD DEG DIA.

PLEASE ACK
SGD/NOAA-NESS

ABXX 13 KWBC
SATELLITE TROPICAL DISTURBANCE SUMMARY
ALL MOVEMENTS AND TRENDS 24 HRS UNLESS OTHERWISE STATED

WEST PACIFIC NOAA 4 VIS/IRDAY 302000-010200Z

23N 126.1E 0022Z T5.5/5.5/DO.5/24HRS RUBY
27.2N 142.3E 2226Z T4.5/4.5MINUS/SO.0/24HRS SALLY

BRKN BAND MOD ACTIVE CONV DEVELOPED FROM YDA EXTENDS 9N 144E TO EQ. 140E TO EQ. 135E DEG WIDE. WIDELY SCTD BAND MOD ACTIVE CONV WEAKER THAN YDA EXTENDS 4N 180W TO 5N 170E TO 13N 160E 1 DEG WIDE.

SOUTH PACIFIC NOAA 4 VIS/IRDAY 301500-32300Z

SCTD BAND MOD ACTIVE CONV SAME AS YDA EXTENDS 10S 150E TO 12S 160E 2 DEG WIDE. SCTD AREA MOD ACTIVE CONV SAME AS YDA 5-7S FROM 147E TO 156E. BRKN AREA MOD ACTIVE CONV DEVELOPED FROM YDA CENTERED ZOS 170E 2 DEG DIA.

7/1 0530 A

Figure 29. Satellite Weather Bulletin

3. Satellite Weather Summary

Description. A weather summary is supplied to television networks as a supplement to satellite weather movie loops. The overlays reveal frontal positions along with high and low pressure centers for both the 00Z and 12Z synoptic analyses. A narrative describing weather highlights for the two synoptic time periods including detailed east and west coast summaries (figure 30) clarifies significant weather events portrayed in the TV movie loop. The overlay and weather summary are supplied with the TV movie loop (mentioned under Movie Loops) to users once per day.

Primary users. Commercial television networks.

TCUS40 KWBC 2

ZCZC WBC589
TCUS40 KWBC 291800Z
SATELLITE WEATHER SUMMARY FOR OCTOBER 29 1979

USA VIEW FROM 7PM EST OCT 28 TO 7AM EST OCT 29

CLOUDS WITH TWO FRONTAL SYSTEMS ARE ON THE MOVIE TODAY WITH SOME CLEAR SKIES IN BETWEEN. ONE FRONT MOVES RAPIDLY EASTWARD THROUGH NEW ENGLAND PUSHING CLOUDS INTO THE ATLANTIC...AND THEN TRAILS WESTWARD ACROSS VIRGINIA AND TENNESSEE. SIGNIFICANT SHOWERS FELL ALONG THE FRONT IN TENNESSEE AND TO THE SOUTH IN MISSISSIPPI AND ALABAMA. ONLY VERY LIGHT RAIN FELL ALONG THE REMAINDER OF THE FRONT EXCEPT IN NORTHERN NEW ENGLAND WHERE A LOW PRESSURE CENTER ALSO HELPED PRODUCE SOME SNOW. A SECOND FRONT EXTENDS FROM MINNESOTA TO COLORADO. THE LARGE AREA OF CLOUDS NORTH OF THIS FRONT IS ASSOCIATED WITH A DEVELOPING SNOW STORM CENTERED IN SOUTHERN COLORADO. SNOW BEGAN ACCUMULATING OVERNIGHT IN NORTHERN COLORADO AND WYOMING. CLEARING OCCURS ALONG THE WEST COAST BEHIND THIS DEVELOPING STORM.

EASTERN U. S. VIEW FROM 7AM TO NOON EST OCT 29

GRAY LOOKING LOW CLOUDS REMAIN OVER NEW ENGLAND AND MOST OF THE NORTHEAST. A LOW DEVELOPS IN NORTHERN MISSISSIPPI ALONG THE STATIONARY FRONT THERE. THIS DEVELOPMENT SHOWS UP NICELY ON THE SATELLITE PICTURE AS A LARGE COMMA SHAPED AREA OF CLOUDS AND SHOWERS IS EAST OF THE LOW CENTER. CLEAR SKIES EXTEND FROM THE MIDWEST ACROSS THE SOUTHERN PLAINS TO WEST TEXAS. THE INCREASING LARGE MASS OF CLOUDS ASSOCIATED WITH THE DEVELOPING SNOW STORM IN COLORADO EXTENDS FROM THE DAKOTAS TO ARIZONA.

WESTERN U. S. VIEW FROM 7AM TO NOON EST OCT 29

CLOUDS WITH THE DEVELOPING SNOW STORM CAN BE SEEN IN THE ROCKIES. BUILDING HIGH PRESSURE BRINGS CLEAR SKIES ALONG THE WEST COAST. OFF THE NORTHWEST COAST...CLOUDS ARE APPROACHING AHEAD OF A LOW AND COLD FRONT.

Figure 30. Satellite Weather Summary

4. Cloud Top and Tropopause Message

Description. The Cloud Top and Tropopause message (figure 31) is a list of chosen latitude-longitude or weather station locations and the tropopause height, cloud-top height and temperature of cloud tops at that location including any relevant remarks. Cloud top temperatures (reported to the nearest degree Celcius) are provided from interactive man-computer retrieval of current infrared digital data received from the SMS/GOES satellites. These retrieved temperatures are matched with the latest NMC prognosis or analysis to determine the relative height (reported to the nearest hundred feet) in the atmosphere. Tropopause height is requested directly from the latest NMC prognosis or analysis. This message is sent out to users by teletype four times per day after each major synoptic time period.

Accuracy. For temperature estimation of cloud tops the accuracy (Hubert, 1979 personal cummunication) is as good as ±1°C and heights ±25mb for deeply convective clouds degrading as the cloud becomes thinner or its emissivity diminishes less than 1. No accuracy determinations of tropopause height from the NMC prognosis or analysis has yet been made.

Primary users. This product is available to most domestic weather operations.

NNNN↓↓A
ZCZC WBC509
TBXX10 KWBC 261200
DCA SFSS CLOUD TOP AND TROPOPAUSE MESSAGE

THE FOLLOWING CLOUD TOP TEMPERATURES WERE DERIVED FM SMS 2 260900Z INFRARED DATA WHILE CLD TOP AND TROP HGTS ARE FROM NMC 260000Z GLOBAL ANALYSIS. HGTS ARE IN HNDS OF FT AND TEMP IN DEG C.

LCTN	TOP HGT	TOP TMP	TROP HGT	REMARKS
BOS	310	M36	460	JTSTR
PIT	370	M49	450	HIGHEST TOPS NR EDGE OF BND
NYG	300	M30	520	OVC HI LVL CLDSIN SWLY FLOW
RDU	300	M30	540	
CAE	290	M29	520	
CGS	310	M32	510	
OCEAN AREA...				
40N42W	100	P04	450	SC
40N50W	210	M12	490	CLDNS ASSOCD WITH SFC CDFNT
45N60W	240	M16	510	
38N61W	440	M62	510	TSTM
30N75W	420	M55	550	

END

Figure 31. Cloud Top and Tropopause Message

5. Tropical Disturbance Summary

Description. The Tropical Disturbance Summary (figure 32) is a coded message listing all Satellite Weather Bulletins sent during the previous 24 h and the locations of all vortices with tropical history, significant disturbed areas, and the Intertropical Convergence Zone (ITCZ). Two summaries are sent out via teletype per day for each ocean area covered. These areas are the Atlantic, East Pacific (to 140°W), Central Pacific, West and South Pacific, and the Indian Ocean. The summaries are prepared by meteorologists using visible and infrared satellite imagery from both the polar-orbiting and geostationary satellites. With the reception of these summaries, the coastal and marine areas of the globe can keep a watchful eye on significant tropical weather situations.

Accuracy. The movement is given to the nearest degree of latitude (±60 nm or 112 km). Position location is given to the nearest degree of latitude/longitude.

Primary users. The product is used by foreign weather operations.

ABSS 16 KWBC

SATELLITE TROPICAL DISTRUBANCE SUMMARY

ALL MOVEMENTS AND TRENDS 24 HRS UNLESS OTHERWISE STATED

CENTRAL AND WEST PACIFIC NOAA-4 IRNITE 270543Z TO 271330Z

BRKN MODERATELY ACTIVE TO ACTIVE ITCZ HAS INCREASED IN INTENSITY...
ITCZ 3 TO 4 DEG WIDE BEGINNING IN EAST PACIFIC FROM 9N 140W TO 5N
155W TO 6N 177W TO 4N 168E.
MODERATELY ACTIVE CONVECTIVE AREA THAT HAS WEAKNENED AND MOVED 4 DEG
TO THE WEST...5 DEG DIAMETER CENTERED 13N 131E.
BRKN MODERATELY ACTIVE CONVECTIVE AREA THAT HAS INCREASED IN ACTI-
VITY PAST 12 HRS...5N TO 19N BETWEEN 120E AND 126E.
BRKN ACTIVE CONVECTIVE AREA BOUND BY 20N 160E TO 18N 172E TO 33N
175E TO 20N 160E...HAS EXHIBITED LITTLE MOVMNT AND CHANGE.
VORTEX DESCRIBED BY UPPER CLOUDS AT 34N 164E.

NO TROPICAL CYCLONE ACTIVITY NOTED.

SOUTH PACIFIC NOAA-4 IRNITE 270340Z TO 271127Z

BRKN MODERATELY ACTIVE CONVECTIVE AREA THAT HAS SHOWN LITTLE CHANGE...
BOUND BY 2N 158E TO 10S 160E TO 1N 135E TO 2N 158E.

NO TROPICAL CYCLONE ACTIVITY NOTED.

Figure 32. Satellite Tropical Disturbance Summary

IV. OCEANOGRAPHIC PRODUCTS

A. Sea Surface Temperature (SST) Products

1. Global SST Observations

Description. Global sea surface temperature observations are obtained daily from the polar-orbiting satellite's AVHRR sensor in the infrared spectrum and its High Resolution Infrared Radiation Sounder (HIRS/2) unit. The model used in obtaining these temperatures is the fully automated computer procedure GOSSTCOMP (Global Operational Sea Surface Temperature Computation). The surface temperature observations are derived by a maximum likelihood technique (Crosby and Glasser, 1978) applied to 50km resolution target arrays of GAC (4km resolution) data. Acceptable SST targets are determined by a comparison with coincident equivalent brightness temperatures derived from HIRS/2 data revealing a cloud-free target (Walton et. al., 1976). A correction for atmospheric attenuation is applied to the data by a multiple linear regression technique involving the brightness temperature in the HIRS/2 water vapor channel. The model generates 30,000 to 40,000 time and earth-located values of sea surface temperature daily. The derived observations are stored on computer disk for National Oceanic and Atmospheric Administration (NOAA) numerical forecast models and remote terminal users, entered onto a seven-day magnetic tape archive available through the Satellite Data Services Division (SDSD) of the NCC, and used in the production of global, climatic and regional scale analyses. Selected observations are transmitted twice daily by teletype on the Global Telecommunications System (GTS) (figures 33 and 34).

Accuracy. The accuracy of satellite derived sea surface temperatures is dependent on the nature of the satellite environmental sensors, the computer procedure GOSSTCOMP and the type of sea truth used for comparison, namely NMC ship observations (Pichel et. al., 1979). Accuracy goals are $\pm 1.5^{\circ}C$. These goals are achieved over approximately 70% of the global ocean.

Primary Users. The primary users of this data are the National Weather Service (NWS), oceanographic services, environmental research concerns, and commercial fisheries. The data are archived by the SDSD of NCC.

```
TSXS17 KWBC 251600
YYDD  25100 230//
 444  76402 01102 06094
 444  76601 45084
 444  76701 18088
 444  75004 35110 49106 05134 18124
 444  75108 50106 54106 77098 20116 33114 11116 24120 25122
 444  75307 68116 33120 35122 48124 01134 16134 18140
 444  75409 91102 92100 95094 51112 63114 40124 42120 01138 05148
 444  75604 46150 38154 16148 18170
 444  75712 86104 51136 53126 55120 57128 42158 44142 45142 38146
      00172 16156 19178
 444  74011 94132 96138 97138 65164 68158 33168 35170 38188 13190
      15198 08196
 444  74108 91150 93146 56178 68156 41170 43208 13220 25218
 444  74203 70152 49196 28198
 444  74310 93142 95146 88150 60166 63166 65162 68158 41196 33188
      20196
 444  74402 81144 95154
 444  74508 77178 66194 68196 35226 38210 13264 15242 09216
 444  74512 93164 86164 98170 54190 66186 43194 45206 38192 10216
      04208 15212 08214
 444  74709 91166 98178 60198 66178 68182 40196 46190 48186 09198
 444  73009 93210 89202 66216 68214 41232 43224 48226 10246 08250
 444  73108 90202 93230 60216 72240 40234 23258 10250 03276
```

Figure 33. Teletype Message of Global Sea Surface Temperature Observations.

(First line of bulletin)

TSXXii KWBC YYGGgg
- TS - Data designator : Satellite SST observations
- XX - Geographical designator
  - (a) XN - Northern Hemisphere
  - (b) XS - Southern Hemisphere
  - (c) XX - Unspecified area
- ii - Number of bulletin (i_1 i_2)
  - (a) i_1 - Bulletin number within a given octant
  - (b) i_2 - Global octant

KWBC - Indicator of originating office
YY - Day of month
GG - Hour of day
99 - Minutes of hour

(Second line)

YYDD 25100 230//
- YY - SATOB code designator
- DD - Indicator of surface data
- 25 - Day of month
- 10 - Observation time in hours GMT
- 0 - Tens of minutes of the hour
- 2 - Country of origin (United States = 2)
- 30 - Satellite identifier (30 = TIROS-N;
  31 = NOAA-6;
  32 = NOAA-7; etc.)

(Third line)

444 76402 01102 06094
- 444 - Indicator of new 10° latitude/longitude square
- 7 - Global octant
- 6 - 10° latitude square of observation (6 = 60° square)
- 4 - 10° longitude square of observation
  (4 = 140° or 40° square)
- 02 - Number of observations in the 10° square

(Each following group)

- 0 - Degrees of latitude from 10° square origin
- 1 - Degree deviation in longitude from 10° square origin
- 102 - Sea surface temperature in degrees Celcius * 10

Figure 34. Key to Global Sea Surface Temperature Teletype Message

2. Monthly SST Observation Mean

Description. Monthly displays of mean global sea surface temperatures, monthly observation density, and the standard deviation about the mean are portrayed in contoured Mercator projection geographic charts derived from averaging global SST observations. A 2.5° latitude-longitude quadrangle averaging scheme is applied to the global SST observation digital data base resulting in data files of averaged fields covering a month's period. This digital data is available to NOAA/NESS terminal users and is archived yearly on magnetic tape available from SDSD. Charts of monthly mean SST's, monthly observation density, and standard deviations from the mean are contoured monthly and sent to users. An archive of the charts is kept by SDSD of the NCC.

Accuracy. Satellite derived SST observation monthly means are compared with ship observation monthly means. Accuracy goals are ±1.5°C. These goals are achieved over approximately 70% of the global ocean.

Primary Users. The monthly observation mean data are used internally at NESS and by the National Marine Fisheries Service. An archive is kept by SDSD of National Climatic Center.

3. Large Scale Analyzed SST Fields

Description. The global sea surface temperature (SST) observations provided from computer processing of polar-orbiter AVHRR and HIRS/2 data are used as input in the creation of large scale, global-5.0° (500 km) and 1.0° (100km) grid and regional-0.5° (50km) grid analyzed SST fields. All observations in the vicinity of a grid point are assigned a weight which depends on reliability, average temperature gradient, and the distance between the observation and the field grid point. The weighted observations and the previous analysis grid point temperature are used to arrive at an updated grid point temperature. The 1.0° field is produced daily from all observations obtained during the previous 24 hours. The 5.0° field is created daily by averaging 1.0° field grid point temperatures. The 0.5° field is analyzed weekly using observations from the previous seven days. The analyzed fields are stored on computer disk with semi-monthly archive tapes produced from the 1.0° scale analysis and monthly tapes from the 5.0° and 0.5° scale analyses.

Contour charts produced once a week from the global-1.0° grid analysis data set, cover the earth in Mercator segments of 50° latitude-by-50° longitude from 70°N to 70°S, overlapping at 20°N and 20°S by five degrees (figure 35). The contour interval is 1° Celcius. Questionable areas are manually encircled with heavy lines. Areas where no observations were made in the previous three days are contoured with dashed lines. Each chart segment is labeled by reference to the northern hemisphere (NH), southern hemisphere (SH), or equator (EQ) and the longitude of the western boundary. The date of the chart is the date on which the chart was created; the data depicted are primarily from the previous day.

Regional contour charts provide coverage of the U.S. 200 mile Conservation and Management Zone in approximately 25° latitude-by-25° longitude segments (figure 36) encompassing the east coast from 5°N to 53°N and 52°W to 100°W, the west coast from 15°N to 63°N and 97°W to 145°W, and the Hawaii-Alaska environs from 15°N to 63°N and 142°W to 170°E. The contour interval is 1.0° Celcius. Questionable areas are manually encircled with heavy lines. Areas where no observations were made in the previous seven days are contoured with dashed lines. Each chart segment is labeled according to its geographical area, Atlantic Coast 1, 2 or 3; Pacific Coast 1, 2 or 3; or Hawaii/Alaska 1, 2, 3 or 4. The date of the chart corresponds to the ending date of observations used.

These charts are produced on 310mm sheet film and archived at SDSD. Chart copies are sent to users on a weekly basis. No contour charts of the 5.0° grid fields are produced since this analysis represents an average of the 1.0° grid field.

Two photographic displays are used for quality assessment, one representing the global analysis (figure 37) and the other depicting the regional analysis (figure 38). The global photographic display provides a gray scale representation of sea surface temperatures from -85°C to +61°C in eight tonal steps along with a portrayal of observation density in four tonal steps. The date given is the processing date. Data depicted are primarily from the previous day.

Remote terminal users, having access to the NOAA/NESS computer center, may retrieve analyzed field data stored on the current disk files. A program can be run to extract the latest analyzed fields in sections and display the data in a hardcopy form or on a CRT screen (figure 39).

Analyzed fields of sea surface temperature are useful in monitoring conditions conducive to hurricane formation and intensification, in preparing ocean thermal frontal analyses, as input to weather forecasting models and in research projects concerning the ocean sciences.

Accuracy. The accuracy of SST analyzed fields is dependent on the observation technique, procedure of analysis and, in the case of contour charts, the contour display program (Pichel et al., 1979). Areas of best representation of actual sea surface temperature are those with the greatest number of observations. False gradients occur at borders of data-sparse regions. Ocean areas smaller than the analysis grid, i.e., gulfs, bays, and seas, receive no gridpoint updating. Outside of these areas of concern, normally encircled on contour charts by quality control personnel and outside of data sparse regions which are dashed, the accuracy is ±1.5°C when compared with ship observations.

Primary Users. SST analyzed fields are used by the National Marine Fisheries Service, National Weather Service, environmental research concerns and commercial fisheries. The data charts and tapes are archived by SDSD of the NCC.

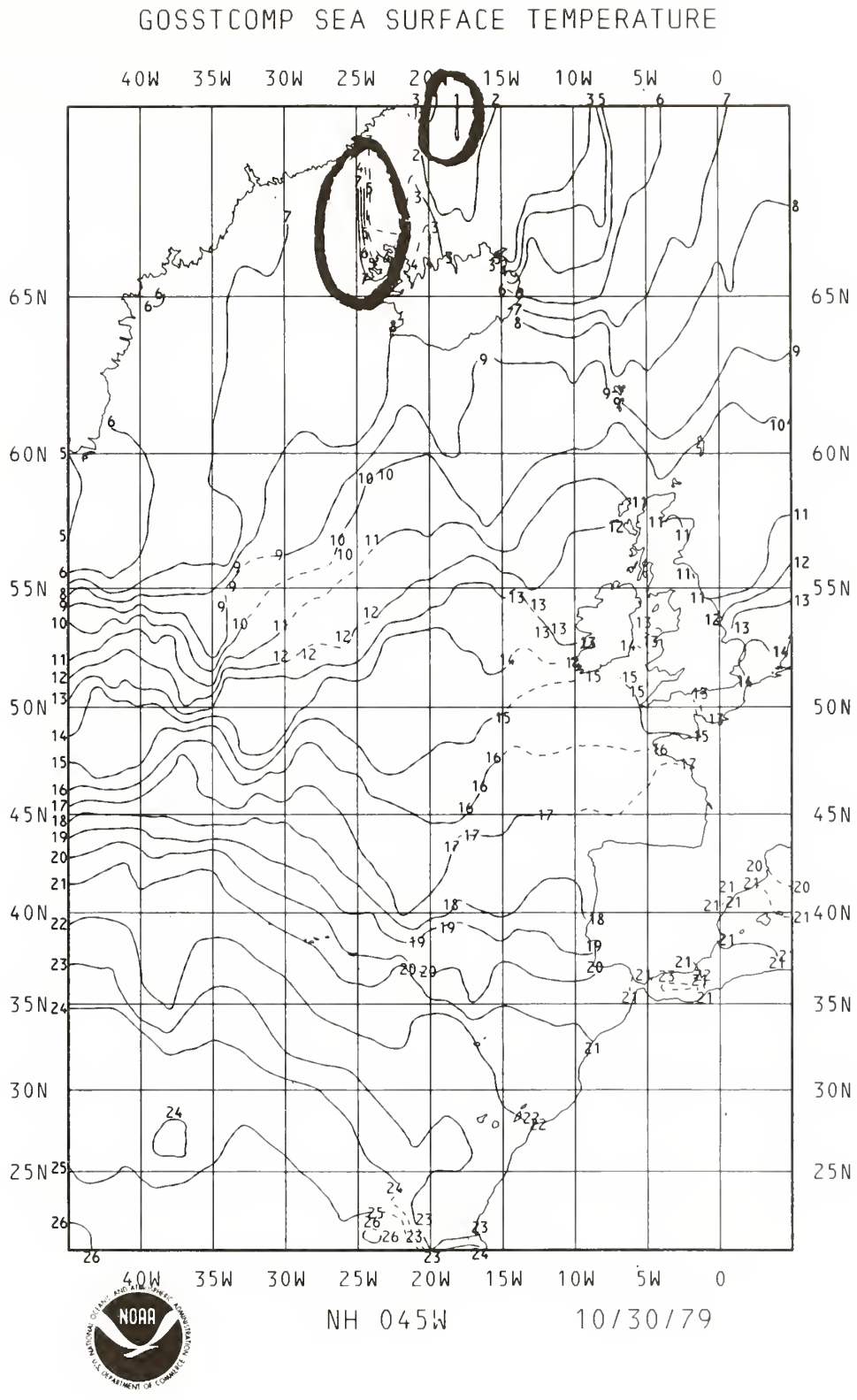


Figure 35. Sea Surface Temperature 1° Analyzed Field

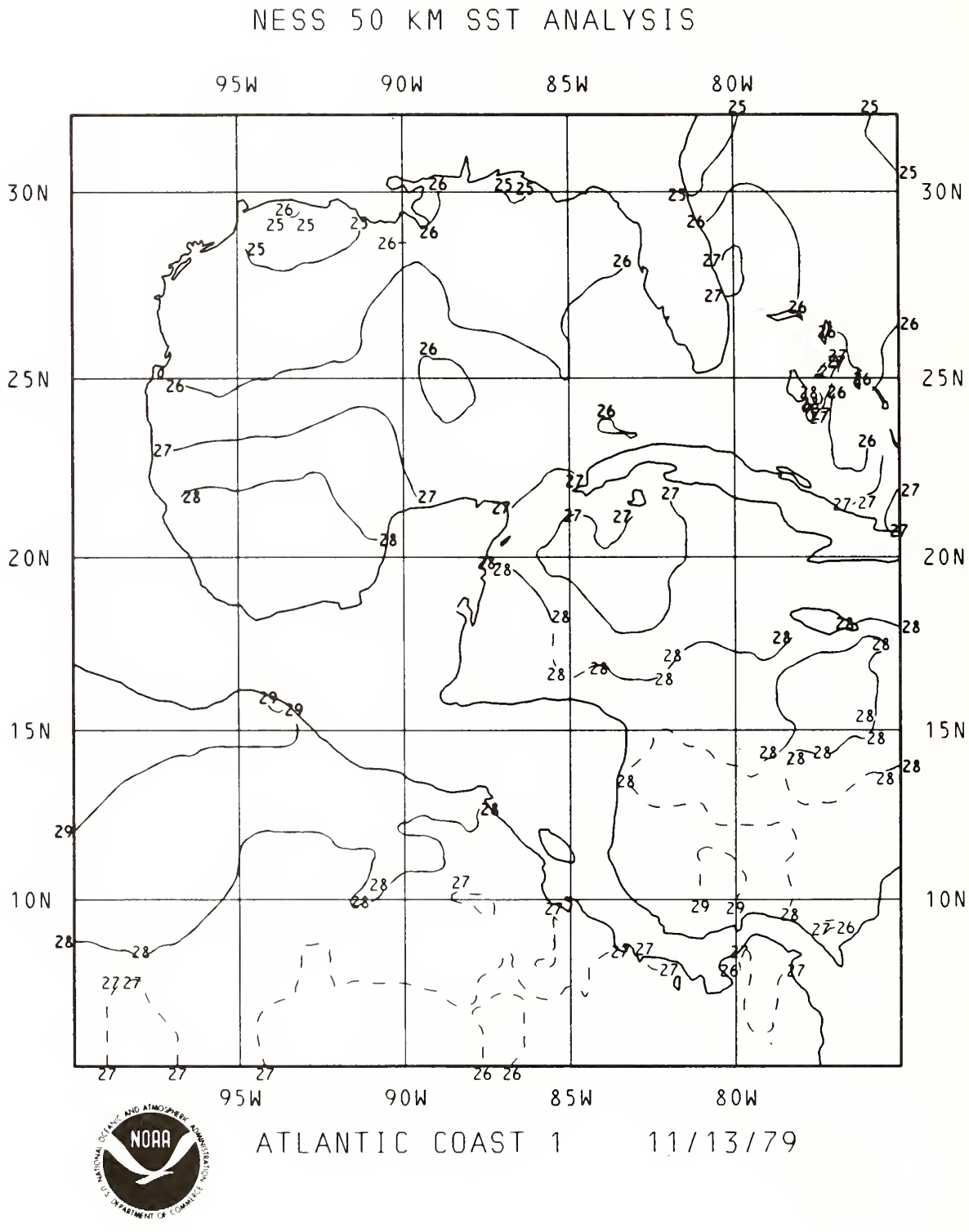


Figure 36. Sea Surface Temperature 0.5° Analyzed Field

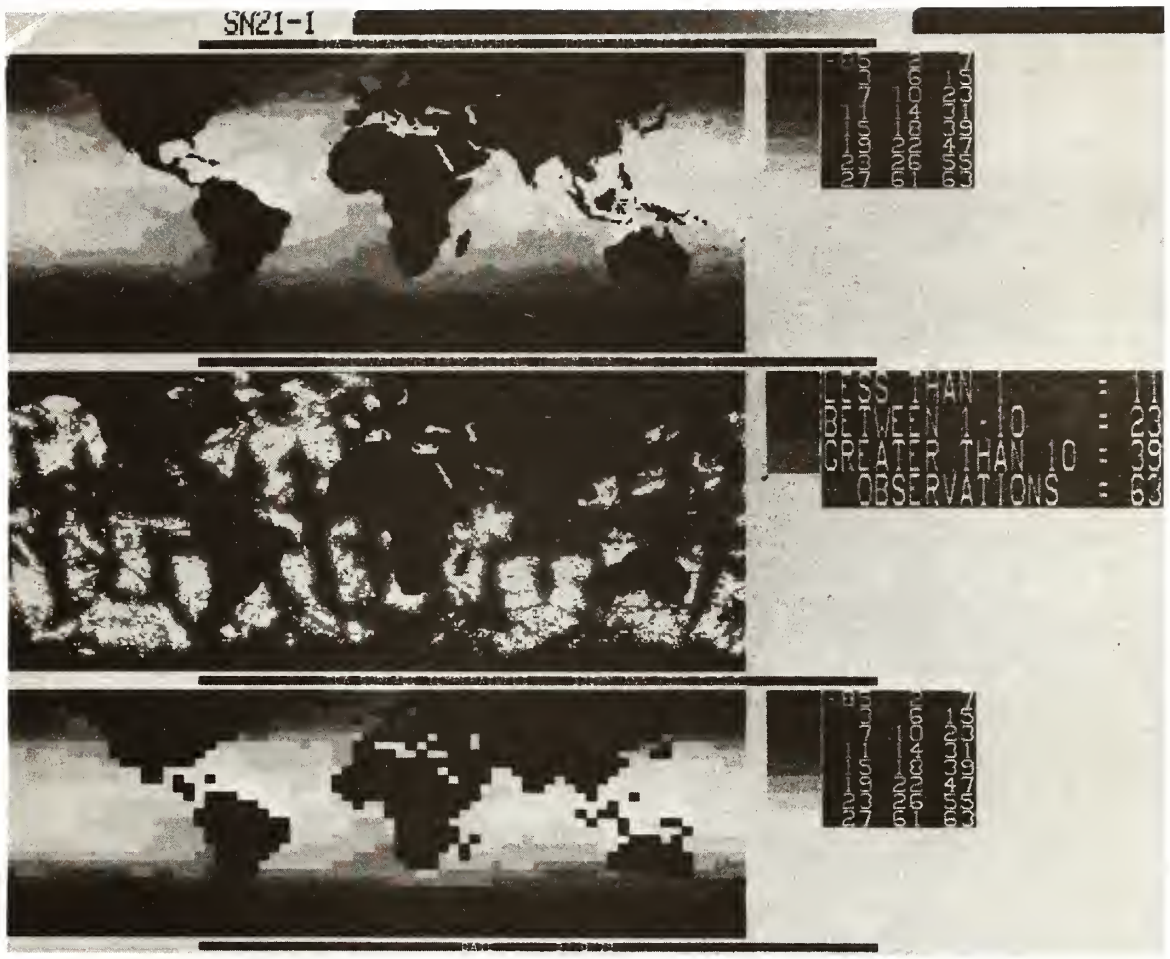


Figure 37. Quality Control Photographic Display of Global and Climatic Scale SST Analyzed Fields

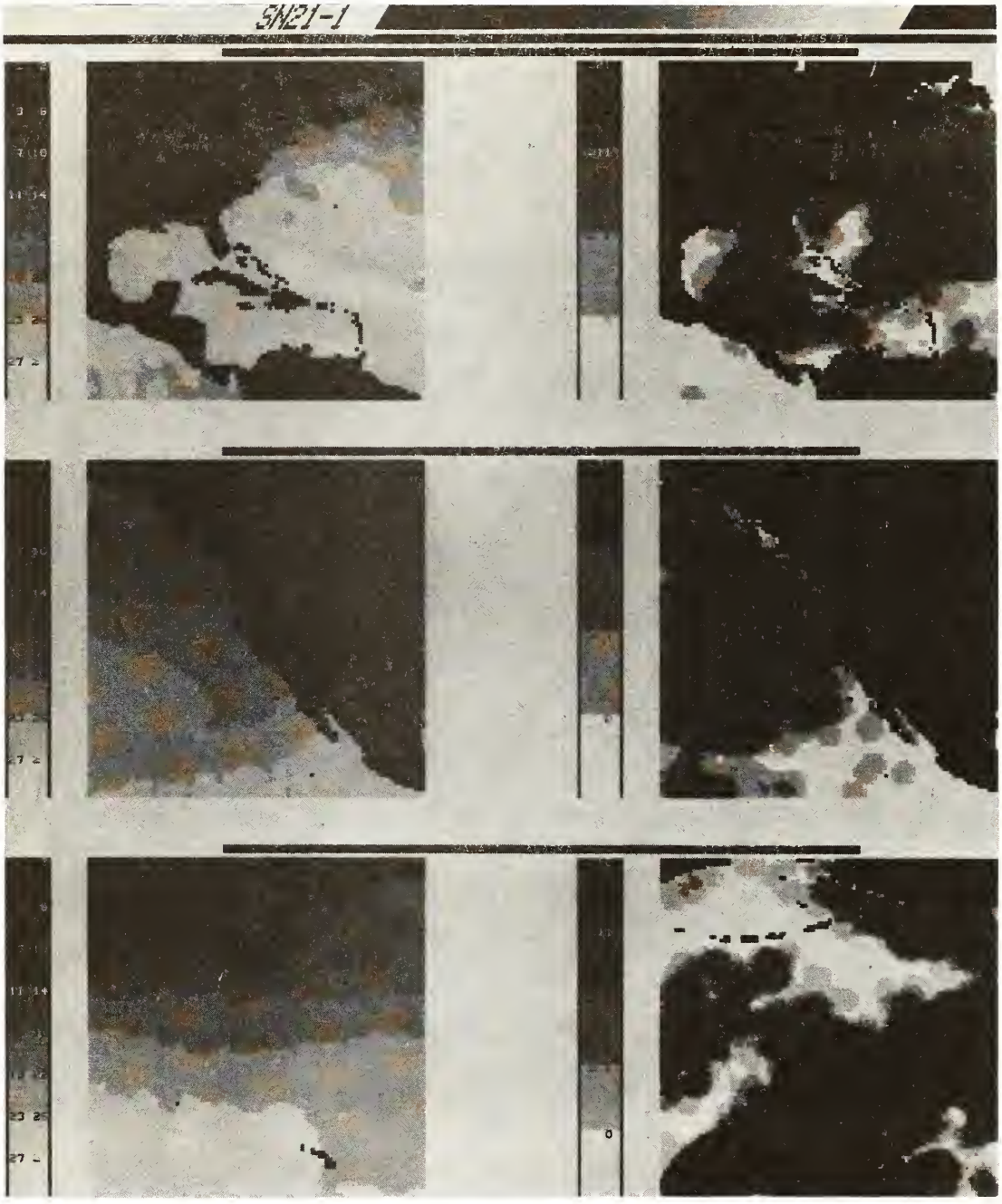


Figure 38. Quality Control Photographic Display of SST Regional Scale Analyzed Fields

GOSSTCOMP SEA SURFACE TEMPERATURES

LONGITUDE WEST OF GREENWICH IN TENTHS OF DEGREES

LATITUDE IN TENTHS OF DEGREES

	900	880	860	840	820	800	780	760	740	720
340	+* **	+* **	+* **	+* **	+* **	+* **	+* **	+2 241	+2 236	+2 233	+2 232	+2 229	+1 225	+1 216
330	+* **	+* **	+* **	+* **	+* **	+* **	+* **	+1 226	+1 221	+1 229	+1 230	+2 232	+1 228	+1 221	+1 216
320	+* **	+* **	+* **	+* **	+* **	+* **	+* **	+1 251	+1 230	+1 224	+1 232	+1 229	+2 229	+1 225	+1 218	+1 216
310	+* **	+* **	+* **	+* **	+* **	+* **	+1 242	+1 245	+1 242	+1 238	+1 236	+1 229	+1 227	+1 223	+1 222	+1 220
300	+* **	+1 231	+1 230	+1 228	+1 227	+* **	+* **	+* **	+1 240	+1 244	+1 244	+1 241	+1 239	+2 229	+1 228	+1 225	+1 225	+1 223
290	+1 236	+1 235	+1 233	+1 230	+1 228	+1 228	+1 227	+* **	+* **	+* **	+1 251	+1 241	+1 247	+1 241	+2 232	+2 232	+1 230	+1 229	+1 229
280	+1 237	+1 237	+1 236	+1 234	+1 231	+1 232	+1 233	+1 237	+* **	+* **	+1 251	+1 249	+1 245	+2 238	+2 235	+2 234	+1 233	+1 232	+1 234
270	+1 239	+1 238	+1 238	+1 238	+1 237	+1 239	+1 238	+1 240	+* **	+* **	+4 253	+3 250	+3 246	+3 237	+2 236	+2 237	+1 237	+1 237	+1 239
260	+1 239	+1 240	+1 243	+1 245	+1 249	+1 249	+1 246	+1 242	+1 248	+* **	+4 258	+3 256	+3 252	+3 238	+2 230	+2 239	+2 241	+1 245	+1 248
250	+1 241	+1 245	+1 251	+1 255	+1 255	+1 253	+1 249	+1 245	+1 247	+1 242	+1 240	+1 240	+1 251	+3 240	+2 241	+2 243	+2 246	+1 249	+1 253
240	+1 245	+1 250	+1 256	+1 258	+1 258	+1 256	+1 252	+1 248	+1 247	+1 243	+1 241	+1 245	+1 252	+3 252	+3 245	+2 248	+2 251	+1 255	+1 254
230	+1 246	+1 248	+1 253	+1 257	+1 262	+1 263	+1 256	+* **	+* **	+* **	+3 263	+3 260	+3 260	+3 257	+3 247	+2 254	+2 256	+1 256	+1 255
220	+1 245	+1 246	+1 250	+1 255	+1 268	+1 269	+* **	+* **	+* **	+* **	+* **	+* **	+* **	+3 262	+3 258	+2 259	+2 260	+1 258	+1 256
210	+* **	+* **	+* **	+* **	+1 272	+1 270	+1 269	+1 267	+1 266	+1 265	+1 261	+1 260	+* **	+* **	+* **	+3 262	+2 262	+1 259	+1 257
200	+* **	+* **	+* **	+1 268	+1 270	+1 270	+1 269	+1 267	+1 266	+1 266	+1 264	+1 261	+1 261	+* **	+* **	+* **	+ 266	+* **	+* **
190	+* **	+* **	+* **	+1 267	+1 268	+1 269	+1 268	+1 267	+1 266	+1 266	+8 264	+8 263	+A 263	+A 258	+A 258	+A 258	+A 258	+* **	+* **
180	+* **	+* **	+1 264	+1 265	+1 267	+1 267	+1 267	+C 267	+D 266	+E 265	+F 265	+G 266	+G 266	+G 265	+E 262	+8 258	+A 257	+A 259	+* **
	900	880	860	840	820	800	780	760	740	720

LOCATION OF TEMPERATURE WITH REFERENCE TO LAT LONG GRID

+5 -AGE OF TEMPERATURE IN DAYS,IF BLANK OVER 9 DAYS.
IF LETTERED 1 DAY OLD,WHERE THE NUMBER OF OBSERVATIONS USED IN ANALYSYS
AT POINT IS GIVEN IN LETTER CODE, A IS 1-4 OBS,B IS 5-8...ETC
145-TEMPERATURE IN DEGREESX10 CENTIGRADE
(RIGHT JUSTIFIED)

LAND IS SIGNIFIED BY ASTERISKS

Figure 39. Remote Terminal Printer Display of Sea Surface Temperature Analyzed Field Data

4. Great Lakes and Coastal Surface Water Temperature Analyses

Description. Analyses of the Great Lakes surface temperatures (Strong 1974) and designated coastal zone sea surface temperatures are produced as observed (whenever cloud free) from the data obtained from the polar-orbiting satellite's High Resolution Picture Transmission (HRPT) displays. The data are computer analyzed for each region with a contour interval of 1°C. The final products (figures 40 and 41) are then manually adjusted for accuracy and mailed to users.

The surface temperature analyses are useful in determining the rate of lake freeze and areas of upwelling. With this knowledge plus observed weather and ice-observed conditions, a forecast can be made for the routing of ships and in predicting the length of the shipping season.

Accuracy. This product has been checked, using ship observations to determine its accuracy. The surface temperature analysis can experience an overall bias of ±1.5°C absolute. The accuracy of the sensor in observing temperature is ±0.5°C relative. Observations are limited to cloud-free situations.

Primary Users. The Great Lakes and Coastal Surface Water Temperature Analyses are used by NWS, commercial marine transportation, research concerns, internally at NESS and an archive is kept by SDSD of NCC.

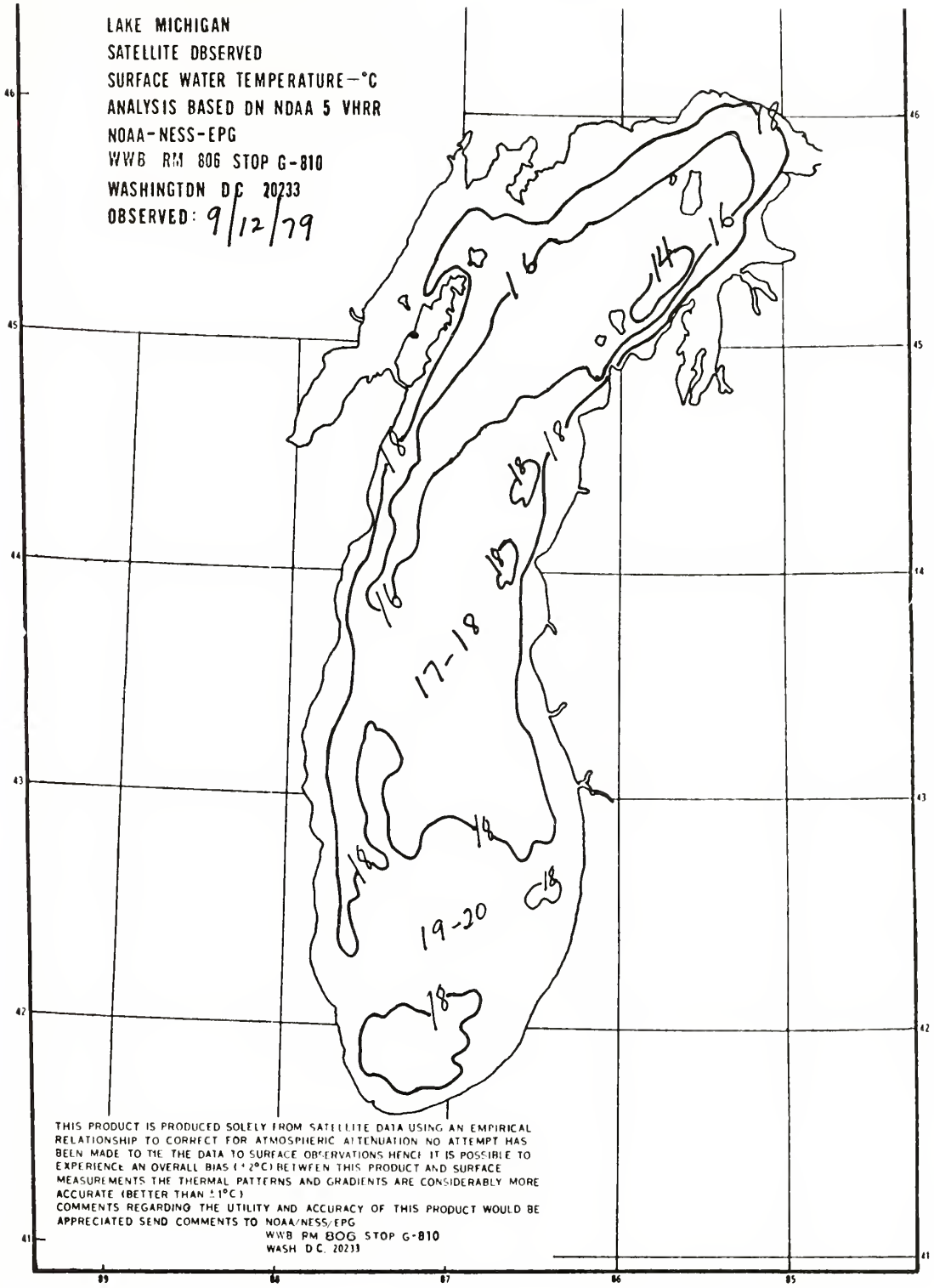


Figure 40. Great Lakes Surface Temperature Analysis

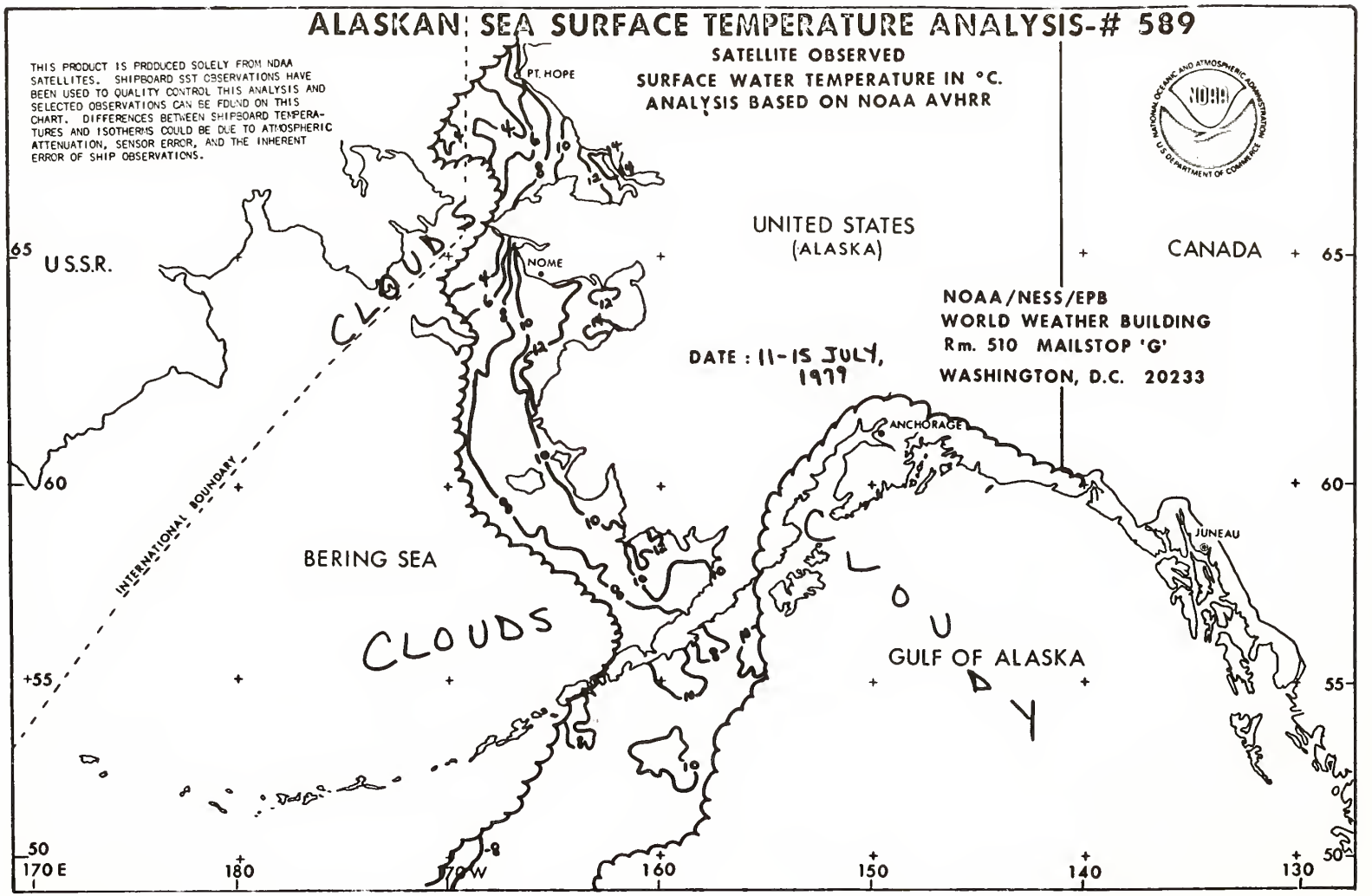


Figure 41. Coastal Surface Water Temperature Analysis

B. Ice Charts

1. Great Lakes Ice Analysis

Description. The Great Lakes ice analysis is a detailed description of ice conditions in the sea-ways of the North American Great Lakes, as viewed from satellite photographic imagery. Twice weekly, during the northern hemisphere winter season, analysis of AVHRR LAC and GOES VISSR imagery is performed when the lakes are cloud free to determine the extent of ice concentration, areas that are ice-fast and ice-free as well as navigable passageways (leads). The chart (figure 42) is sent to users via the National Facsimile (NAFAX) Network and by mail.

This analysis is useful in forecasting the limits of the shipping season and for the routing of commercial shipping.

Accuracy. Human analysis and chart resolution produce an accuracy of positioning to within ±5km.

Primary Users. The Great Lakes ice analysis is used by commercial marine transportation, U.S. Coast Guard, National Marine Fisheries Service, varied research concerns and is archived by SDSD of NCC.

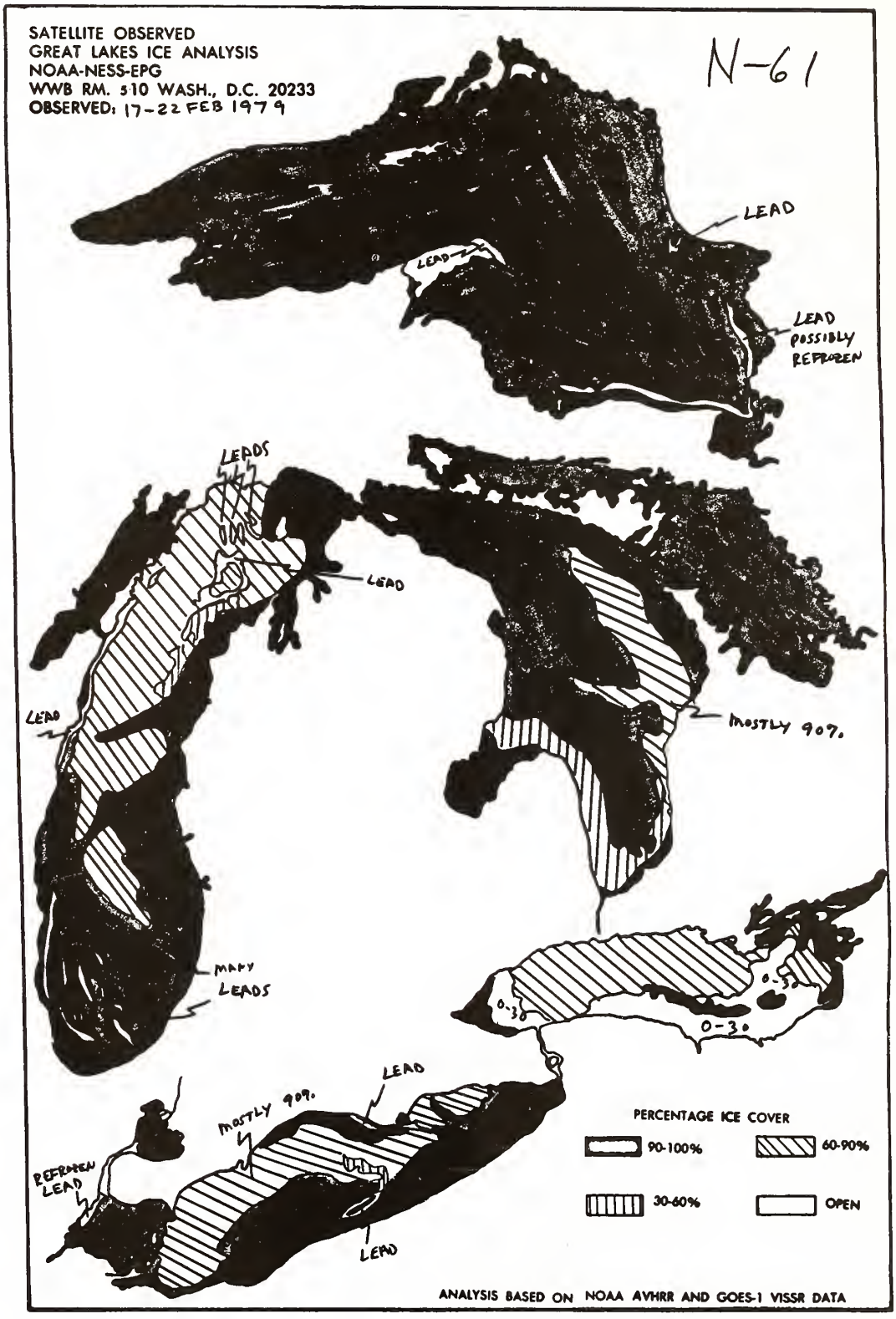


Figure 42. Great Lakes Ice Analysis

2. Polar Regional Ice Charts

Description. Charts of various coastal sea ice regions are produced by the Joint Ice Center (NOAA/NESS-Navy) from a combination of AVHRR Local Area Coverage, Stretch-Grid, Defense Meteorological Satellite Project (DMSP) and Nimbus-ESMR photographic imagery, climatological data and shore station and air reconnaissance ice reports. These charts cover five main areas: Alaskan-South, Alaskan-North, Eastern-Arctic, Western-Arctic and Antarctic with occasional local area charts produced when needed.

Alaskan ice charts (figure 43) are 1:5M gridded analyses which include information describing the type of ice, concentration or coverage, ice limits, leads and polynyas (open water areas). The Alaskan-North chart is used up until the polar ice pack has reached a southern limit of 70°N, where coverage is supplied by the Alaskan-South chart. An Alaskan chart is prepared three times a week and is transmitted over the NAFAX network. An archive is kept by SDSD of NCC.

Arctic and Antarctic charts (figures 44 and 45) are 1:10M gridded analyses which have mapped the same features that are provided by the Alaskan charts including the seven day mean position of the +2°C sea surface isotherm and the seven day mean position of the 0°C average air temperature isotherm for the Arctic charts. Along with observed ice limits, estimated and forecasted limits are provided for Arctic charts by use of automated ice forecast models and ice and ocean current climotology. Ice boundary observed and estimated limits are provided for the Antarctic region almost solely from satellite data. These charts are mailed to users once per week, Arctic charts are also transmitted by national facsimile networks and weekly and twice-weekly teletype messages supplement the charts. An archive of these charts is kept by the National Technical Information Service.

Accuracy. An accuracy in ice limit positioning of ±5km is attained with these products.

Primary users. Polar regional ice charts are helpful to commercial marine transportation, U. S. Coast Guard, National Marine Fisheries Service and the U. S. Navy.

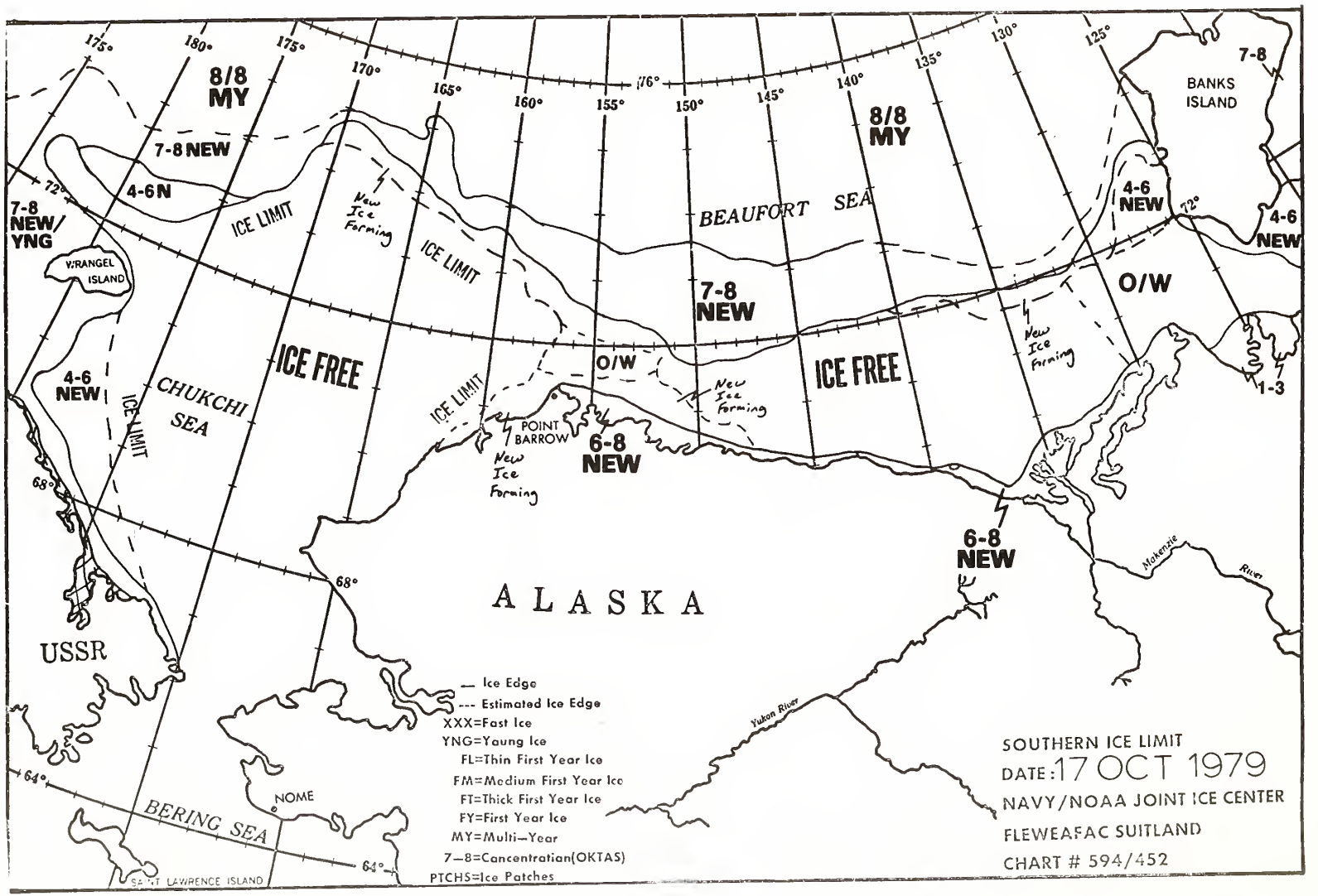


Figure 43. Alaskan-North Ice Chart

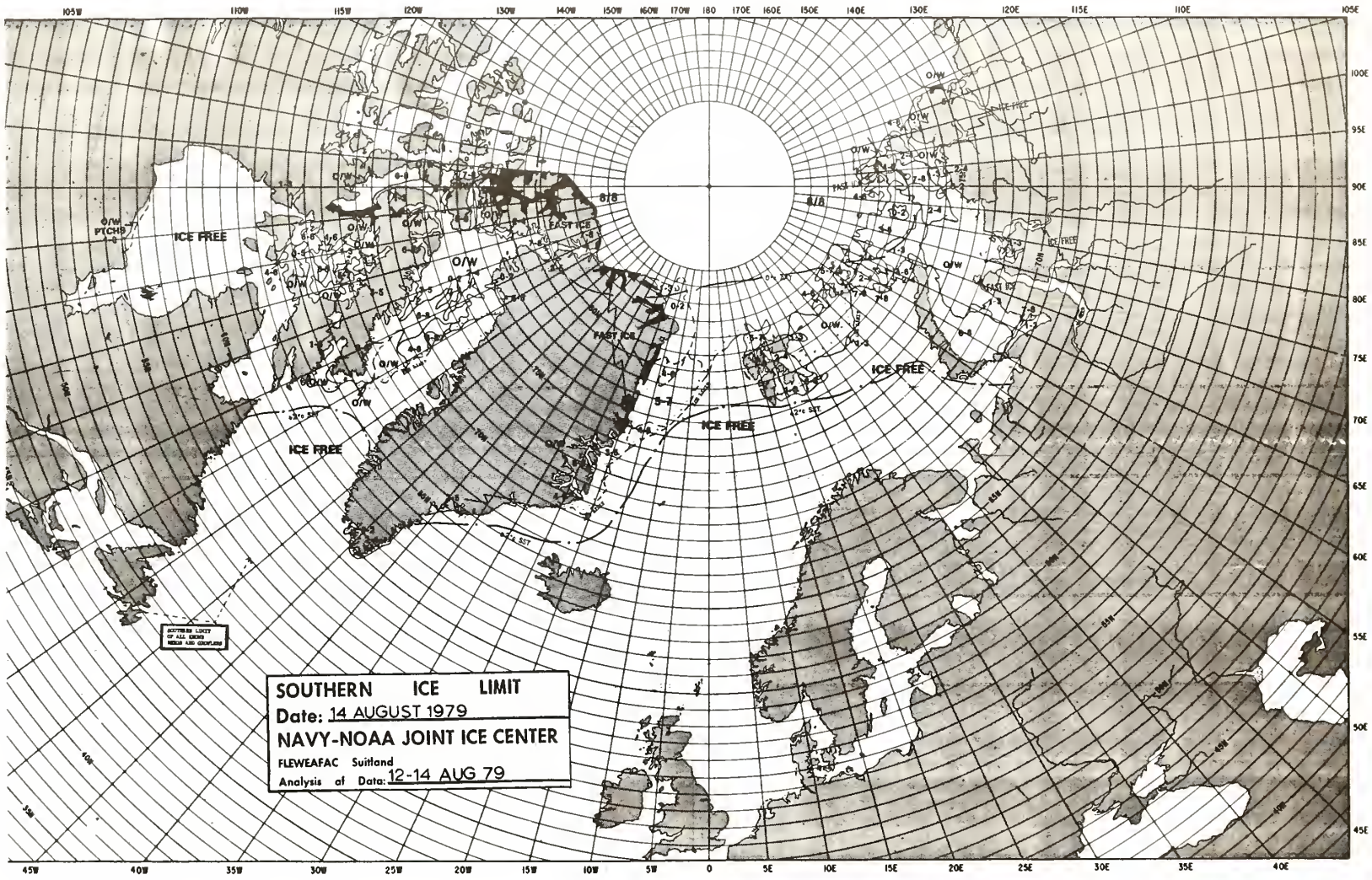


Figure 44. Eastern - Arctic Ice Chart

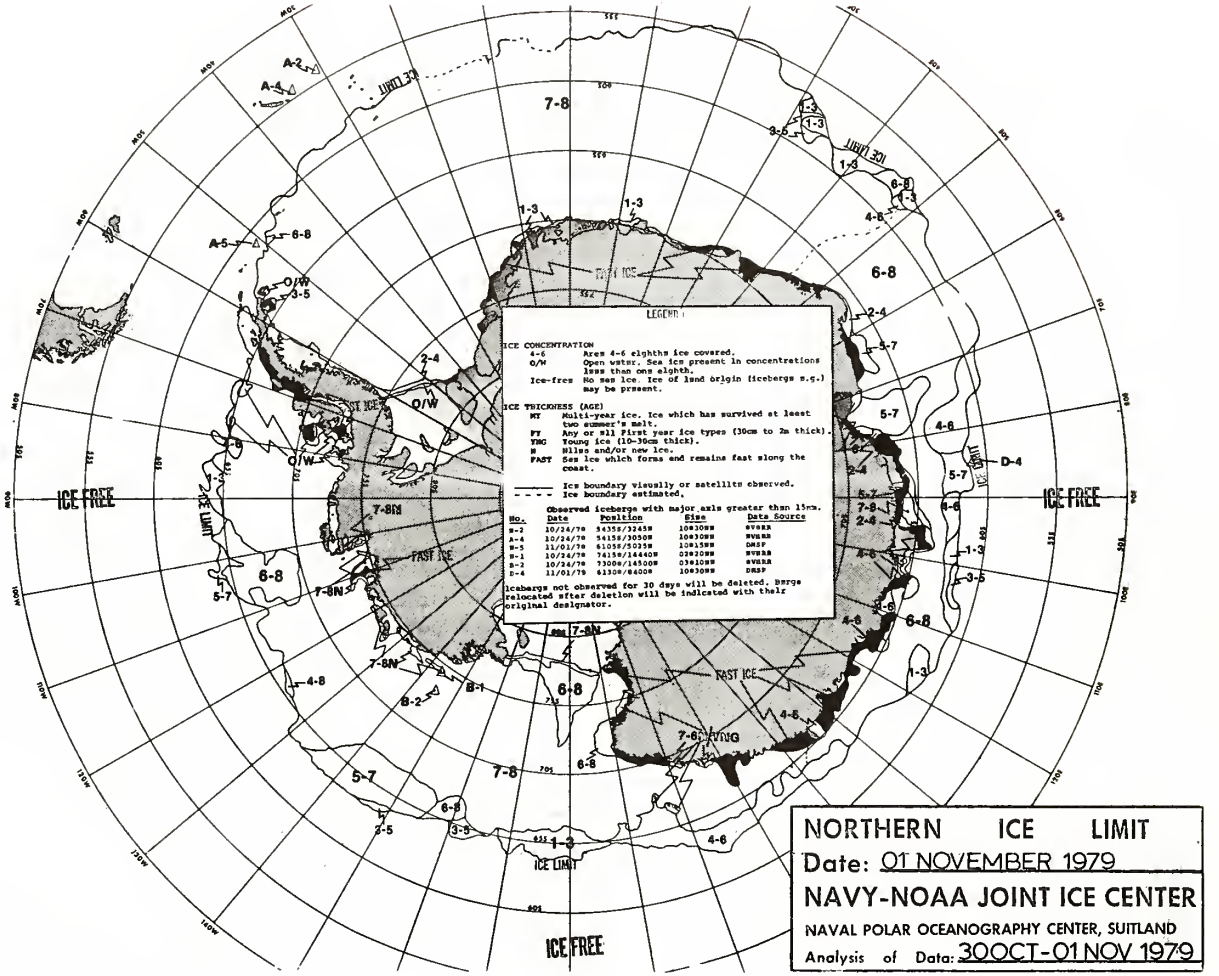

LEGEND
ICE CONCENTRATION
4-6 Area 4-6 eighths ice covered.
O/W Open water. Sea ice present in concentrations less than one eighth.
Ice-free No sea ice. Ice of land origin (icebergs e.g.) may be present.
ICE THICKNESS (AGE)
MY Multi-year ice. Ice which has survived at least two summer's melt.
FY Any or all first year ice types (30cm to 2m thick).
YNG Young ice (10-30cm thick).
N Nilas and/or new ice.
FAST Sea ice which forms and remains fast along the coast.
Ice boundary visually or satellite observed.
Ice boundary estimated.
Observed icebergs with major axis greater than 15nm.
No. Date Position Size Data Source
B-2 10/24/79 54358/3245W 10#30WW #VHRR
A-4 10/24/79 54158/3050W 10#30WW #VHRR
B-5 11/01/79 61058/5035W 10#15WW DMSP
B-1 10/24/79 74158/14440W 03#20WW #VHRR
B-2 10/24/79 73008/14500W 03#10WW #VHRR
D-4 11/01/79 61308/8400W 10#30WW DMSP
Icebergs not observed for 30 days will be deleted. Bergs relocated after deletion will be indicated with their original designator.
ICE FREE
ICE LIMIT
FAST ICE
NORTHERN ICE LIMIT
Date: 01 NOVEMBER 1979
NAVY-NOAA JOINT ICE CENTER
NAVAL POLAR OCEANOGRAPHY CENTER, SUITLAND
Analysis of Data: 30OCT-01 NOV 1979

Figure 45. Antarctic Ice Chart

C. Ocean Current Analyses

1. Gulf Stream Wall Bulletin and Analysis

Description. The western Atlantic currents comprising the Caribbean current, Florida current and Gulf Stream flowing from the eastern Gulf of Mexico around Florida to the 44th parallel along the east coast of the United States are of interest to the mariner in the areas of fishing and shipping. Plotting current position, areas of cold and warm eddies, and shelf/slope water interface help the mariner in reducing costs in transporting merchandise and locating areas of good fishing.

The Gulf Stream Wall Bulletin (figure 46) informs the mariner of the position of the "north wall" or western boundary of the Gulf Stream. The fastest currents are found 12-15 miles seaward of this location. It also indicates eddy locations and diameters. The bulletin is determined through human analysis of polar-orbiter AVHRR and GOES-VISSR imagery. Bulletins of the position of the Gulf Stream Wall are sent out via teletype and marine radio broadcasts three times a week to users.

The Gulf Stream Analysis (figure 47) is a gridded, human analysis of the Gulf Stream prepared from polar-orbiter AVHRR and GOES-VISSR imagery. This analysis is mailed and transmitted via facsimile weekly to users.

Accuracy. Human analysis, chart resolution, and variability of the current produce an accuracy of positioning of ±5km for the bulletin and the analysis.

Primary Users. The users of the Gulf Stream data include coastal marine shipping, fisheries, U.S. Coast Guard, recreation and boating interests, and marine research. An archive of the analyses is kept by the SDSD of NCC.

October 9, 1979

GULF STREAM LOCATION- THE LINE DESCRIBED BY THE FOLLOWING SEQUENCE OF POINTS REPRESENTS THE WEST WALL OF THE GULF STREAM.

27.0/80.0	30.7/80.0	32.7/78.0
32.8/76.7	33.1/76.3	33.5/76.1
34.1/76.1	35.0/74.8	35.7/74.2
36.1/73.1	37.0/72.0	37.2/70.2
37.7/68.9	37.5/66.9	

THE MAXIMUM CURRENT OF THE GULF STREAM LIES APPROXIMATELY 12-15 MILES SEAWARD OF THIS LINE.

COLD EDDIES: 31.3/77.7/50 NMI. DIAM.
31.5/76.3/50 NMI. DIAM.
33.4/74.0/55 NMI. DIAM.

WARM EDDIES: 37.0/74.4/60 NMI. DIAM.
38.7/71.8/90 NMI. DIAM.
42.0/64.7/65 NMI. DIAM.

LATEST SATELLITE DATA: 10/09/79 @ 0900Z

Figure 46. Gulf Stream Wall Bulletin

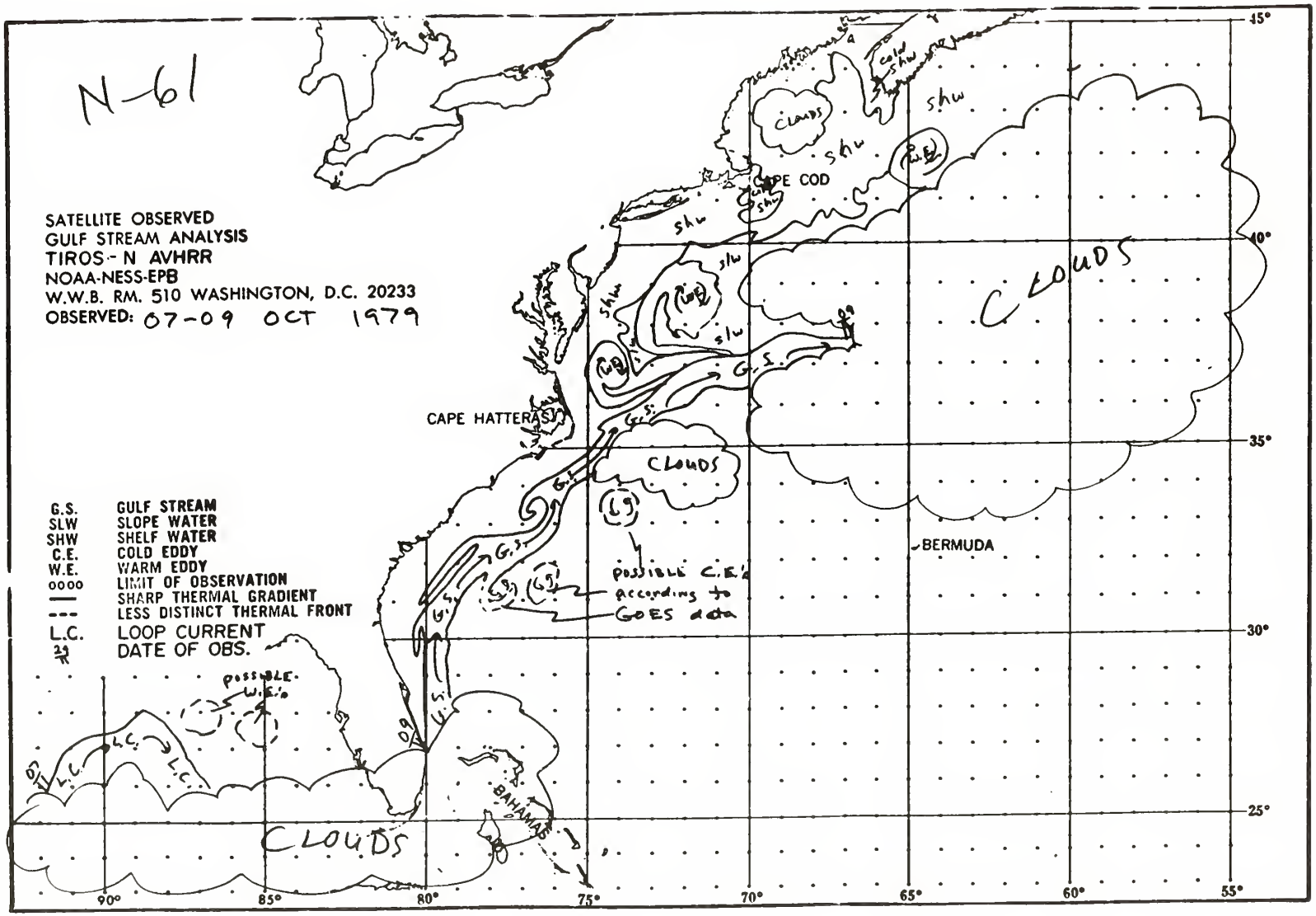


Figure 47. Gulf Stream Analysis

2. West Coast Thermal Front Analysis

Description. The thermal front analysis of the waters off the west coast of the United States has been found to be a useful tool in locating potential areas of good fishing for California fishermen and an aid in coastal research work. When upwelling occurs off the coast, the cold waters abound with nutrients. It is along these boundaries, between cold and warm waters, that the fish gather to feed. Analysis of satellite infrared imagery (figure 48) from the AVHRR on board the polar-orbiting satellite is performed, cloud cover permitting, as often as possible. The thermal fronts are drawn on a gridded chart along with ship observations of sea surface temperature (figure 49) and sent out via telecopier to locations along the west coast. Three different charts are produced, one from 42°N to 40°N provided by the Seattle Ocean Services Unit of the NWS and two from the NESS Satellite Field Service Station in San Francisco, California, for the areas 32°N to 42°N (mostly during the summer time) and areas south of 32°N (mostly during the winter). Analysis is made from the coast out to approximately 4° of longitude. A plastic overlay showing navigation lines and bathometric contours is available on request.

Accuracy. Using AVHRR rectified 1km data, an estimated accuracy of ±5km is achieved in the locations of frontal zones.

Primary Users. Albacore tuna and salmon fishermen. Scientific marine research concerns.

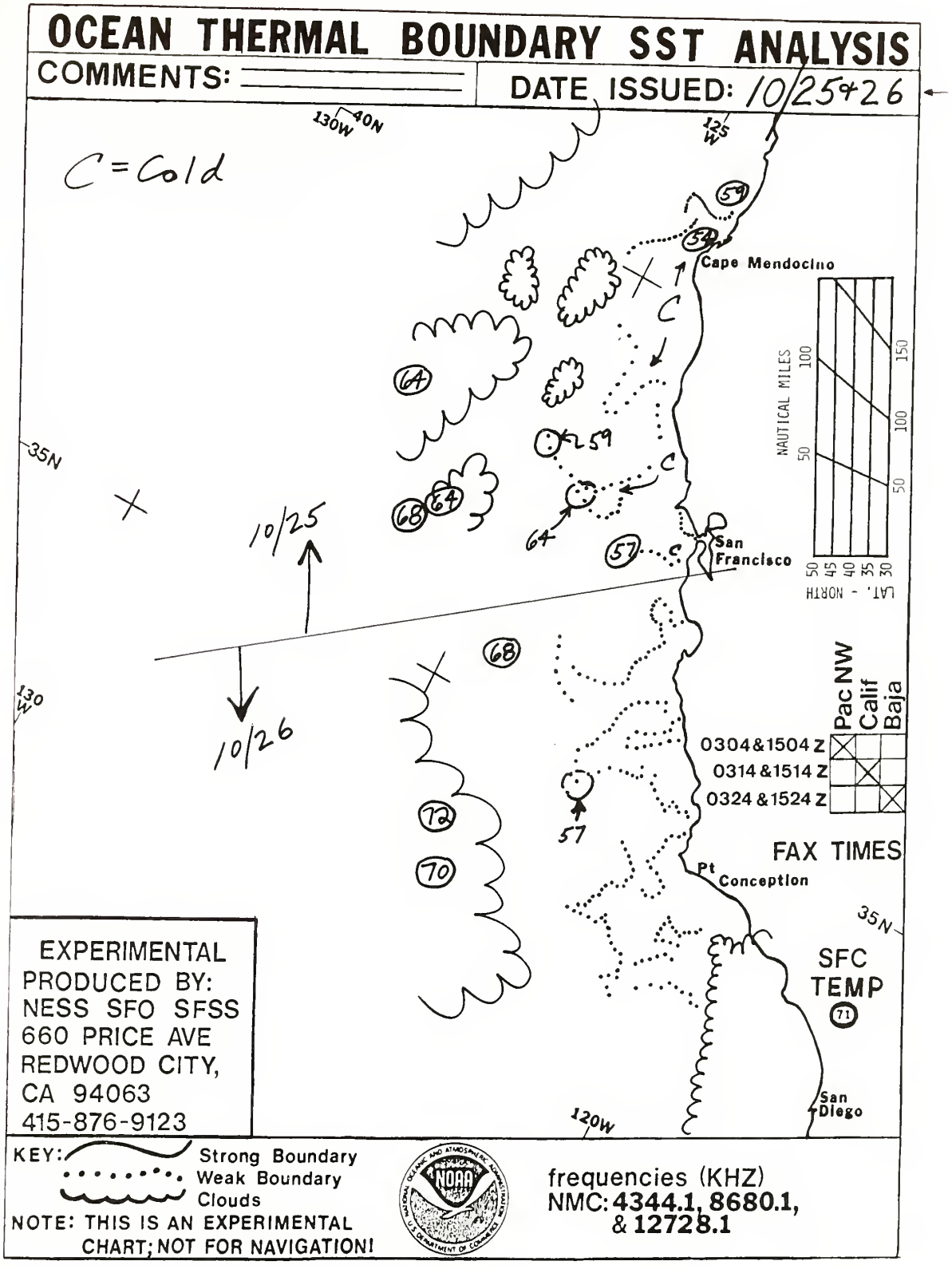


Figure 48. West Coast Thermal Front Analysis

Figure 49. Rectified AVHRR HRPT Data Used for Production of West Coast Thermal Front Analysis

V. HYDROLOGICAL PRODUCTS

A. River Basin Snow Coverage Observations

Description. The percentage-snow-cover message sent out via teletype and the mapped snow-covered basin sent out via telecopier are produced for selected river basins (figure 50) by analysis of polar-orbiter AVHRR and GOES-VISSR photographic imagery. The products are produced whenever a basin is cloud free (usually 1 to 2 days per week). The basin snow cover products are used in run-off forecasting, flood prevention, water resource planning, reservoir/dam regulation, snow survey cross checks, irrigation planning, supply assessment for hydroelectric power generation, research and development and are included in state/regional bulletins.

The message (figure 51) indicates the offices that the observations are directed to and a brief description of the percentage of snow cover, the satellite involved, and the date of the observations.

The mapped data show the snow-covered areas in black.

Table 3 lists the basins for operational snow mapping as of 1978.

Accuracy. The product is accurate to 5% in areas greater than 5,000km^2 (Wiesnet 1974). The accuracy is checked with aerial surveys, ground measurements, computer enhancements of satellite imagery, and, when available, Landsat Multi-Spectral Scanner data.

Primary Users. The primary users of snow basin data are the NWS River Forecast Centers, Corps of Engineers, the Soil Conservation Service, Bureau of Reclamation, U.S. Geological Survey, Department of Energy and are archived by SDSD of NCC.

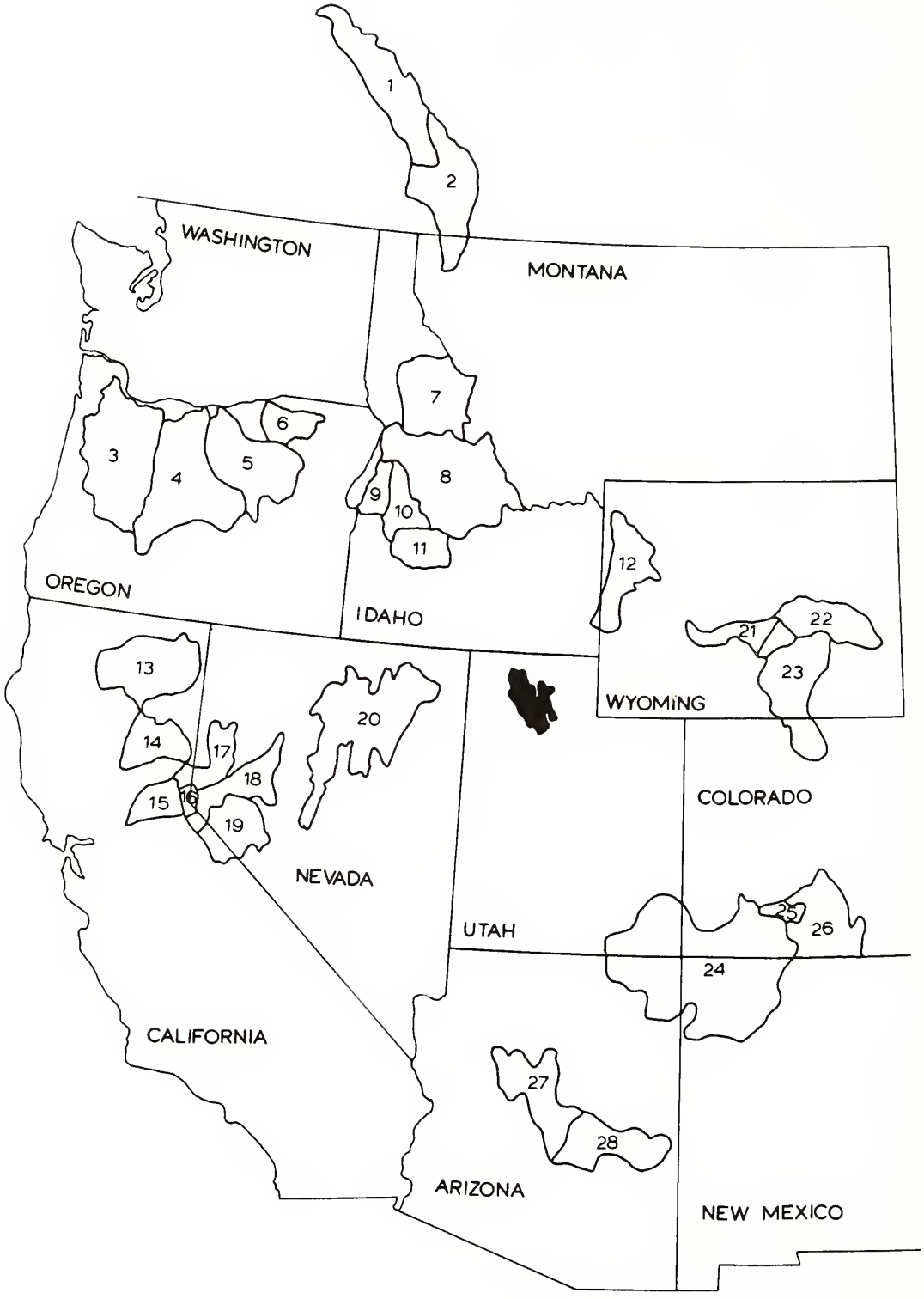


Figure 50. Snow mapped river basins

SPECIAL TO NWS/RFC SACRAMENTO, CALIFORNIA

SACRAMENTO R. BASIN ABOVE SHASTA 63 PERCENT SNOW COVERED AND FEATHER ABOVE OROVILLE 71 PERCENT AS DETERMINED FROM GOES-3 SATELLITE IMAGERY OF 2/6/79.

A.N.S
SCHNEIDER

NESS

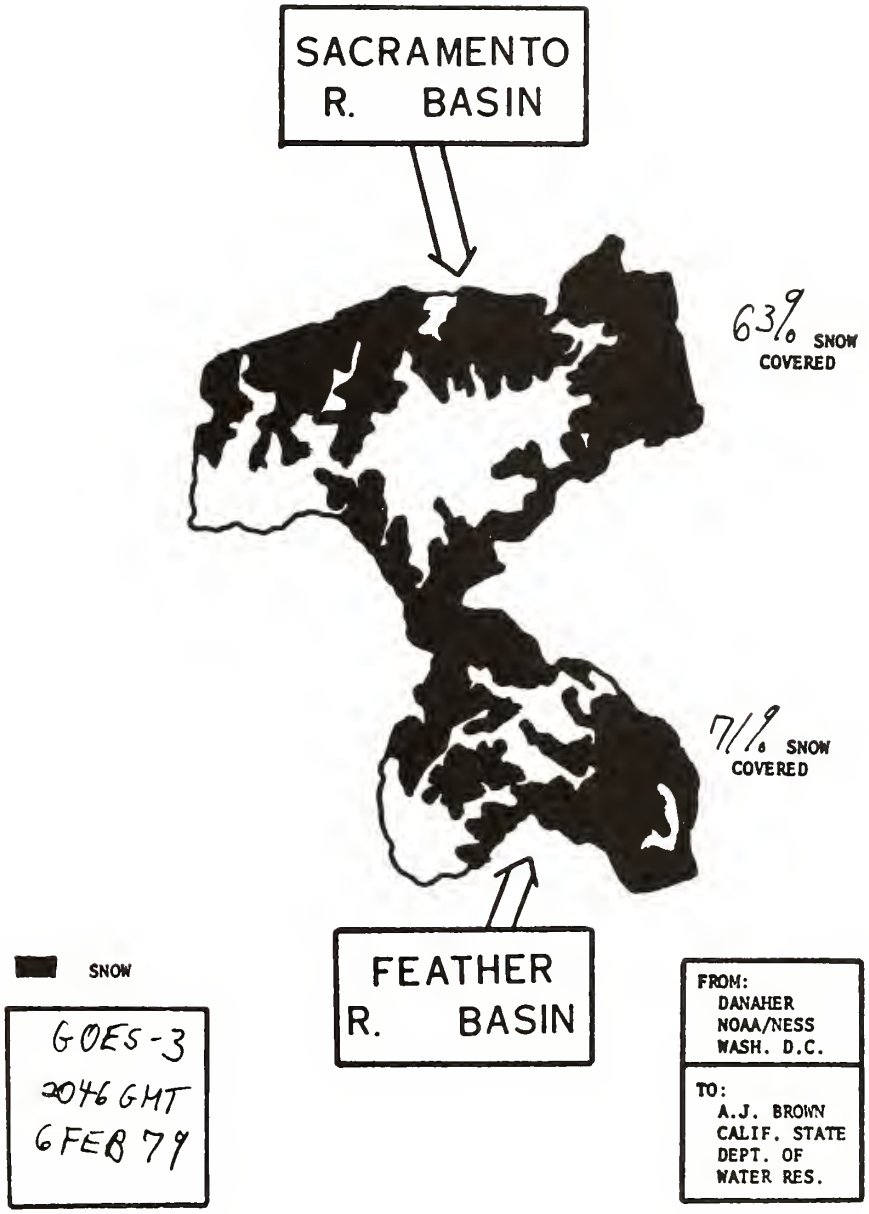


Figure 51. Percent snow cover message and mapped snow covered basin

Table 3. Current basins being mapped as of 1978

River basin	Drainage Area in Km²	Users
American above Fair Oaks (15)	5,601	Sacramento RFC
Boise above Lucky Peak (11)	6,941	Portland RFC, Columbia Basin Network
Carson (18)	8,864	Soil Conservation Service, Sacramento RFC
Clearwater above Pack (7)	20,824	Portland RFC, Columbia Basin Network
Columbia River above Mica Dam (1)	21,290	Portland RFC, Columbia Basin Network, B.C. Hydro & Powar Authority, Environment Canada
Deschutes (4)	27,195	Portland RFC, Columbia Basin Network
Feather above Oroville (14)	9,386	California State Dept. of Water Resources
Humbolt above Comus (20)	31,339	Salt Lake City RFC, Soil Conservation Service
John Day (5)	19,632	Portland RFC, Columbia Basin Network
Kootanay above Libby (2)	23,277	Portland RFC, Columbia Basin Network
Missouri River above Canyon Ferry Dam	40,714	Soil Conservation Service, Great Falls RDO
North Platte between Alcova and Guernsey (22)	2,198	Bureau of Reclamation, Kansas City RFC, Soil Conservation Service
North Platte above Saminoe (23)	15,274	Bureau of Reclamation, Kansas City RFC, Soil Conservation Service
Northeast U.S. Snow Map		NE Regional Hydrologist NWS
Payette above Emmett (10)	6,941	Portland RFC, Columbia Basin Network
Rio Grande above Colo.-New Mexico State Line (26)	19,900	Soil Conservation Service, Fort Worth RFC
Rio Grande above Del Norte (25)	3,419	Soil Conservation Service, Fort Worth RFC
Sacramento above Shasta (13)	16,630	California State Dept. of Water Resources
Salmon above Whitebird (8)	35,095	Portland RFC, Columbia Basin Network
Salt (28)	16,141	Salt Lake City RFC, Phoenix RDO, Salt River Project, U.S. Geological Survey
San Juan (24)	65,273	Salt Lake City RFC
Snake above Palisades (12)	13,340	Portland RFC, Columbia Basin Network
St. John	55,167	Marine Bureau of Civil Emergency Preparedness, New Brunswick Dept. of Environment, Environment Canada, St. John Basin Task Force
Sweetwater above Pathfinder (21)	6,027	Bureau of Reclamation, Kansas City RFC, Soil Conservation Service
Tahoe-Truckee (16,17)	7,665	Soil Conservation Service, Sacramento RFC
Umatilla (6)	5,931	Portland RFC, Columbia Basin Network
Verde (27)	17,094	Salt Lake City RFC, Phoenix RDO, Salt River Project, U.S. Geological Survey
Walker (19)	9,241	Soil Conservation Service, Sacramento RFC
Weiser (9)	3,781	Portland RFC, Columbia Basin Network
Willamette (3)	26,159	Portland RFC, Columbia Basin Network

Notes on Users:

1. The Columbia Basin Network includes the Soil Conservation Service, Bureau of Reclamation, U.S. Geological Survey, U.S. Army Corps of Engineers, National Weather Service, Bonneville Power Administration, B.C. Hydro and Power Authority, as well as other state and local agencies.

2. Basins being done for the Bureau of Reclamation in Denver, Colorado, are retransmitted from the site to field offices in Casper, Laramie, and Cheyenne, Wyoming.

3. The St. John Basin Task Force includes the National Weather Service, U.S. Army Corps of Engineers, U.S. Geological Survey, Environment Canada, and other state, provincial agencies.

4. Most basins are mapped twice weekly cloud cover permitting. The Salt, Verde and St. John basins are mapped daily cloud cover permitting. The Tahoe-Truckee, Carson and Walker basins are mapped only at the end of each month.

B. Regional Snow Cover Analyses

Description. The Regional Snow Cover Analyses are graphical (1:7.5M and 1:10M) displays of snow cover for selected regions of the world produced from analysis of GOES-VISSR and polar-orbiter stretched gridded imagery. The current regions mapped are the Great Lakes, Northeastern United States and the Himalayas with corresponding spatial resolution of 1km (western hemisphere GOES) and 4km (GAC data only-eastern hemisphere).

The analyses (figure 52) are produced from direct overlay of the photographic imagery with a gridded boundary map. Users are provided with a political/geographic boundary map indicating areas covered by snow and those unobservable due to clouds. These products are sent out via telecopier twice a week for western hemisphere observed regions and once a week for eastern.

Regional Snow Cover Analyses find their usefulness in forecasting lake inflow amount/rates (Great Lakes), water supply (Northeastern U.S.), and flood watch and drought monitoring (Himilayas).

Accuracy. From hand analysis, map and photographic imagery resolution, an accuracy of snow boundary positioning of ±5km is achieved.

Primary users. Great Lakes Region - Corps of Engineers, Detroit District; Northeastern U.S. - NWS Eastern Region (Hartford, Harrisburg, Cincinnati - River Forecast Centers); and Himilayas - Joint Agricultural Weather Facility - USDA/NOAA. An archive is kept by SDSD of NCC.

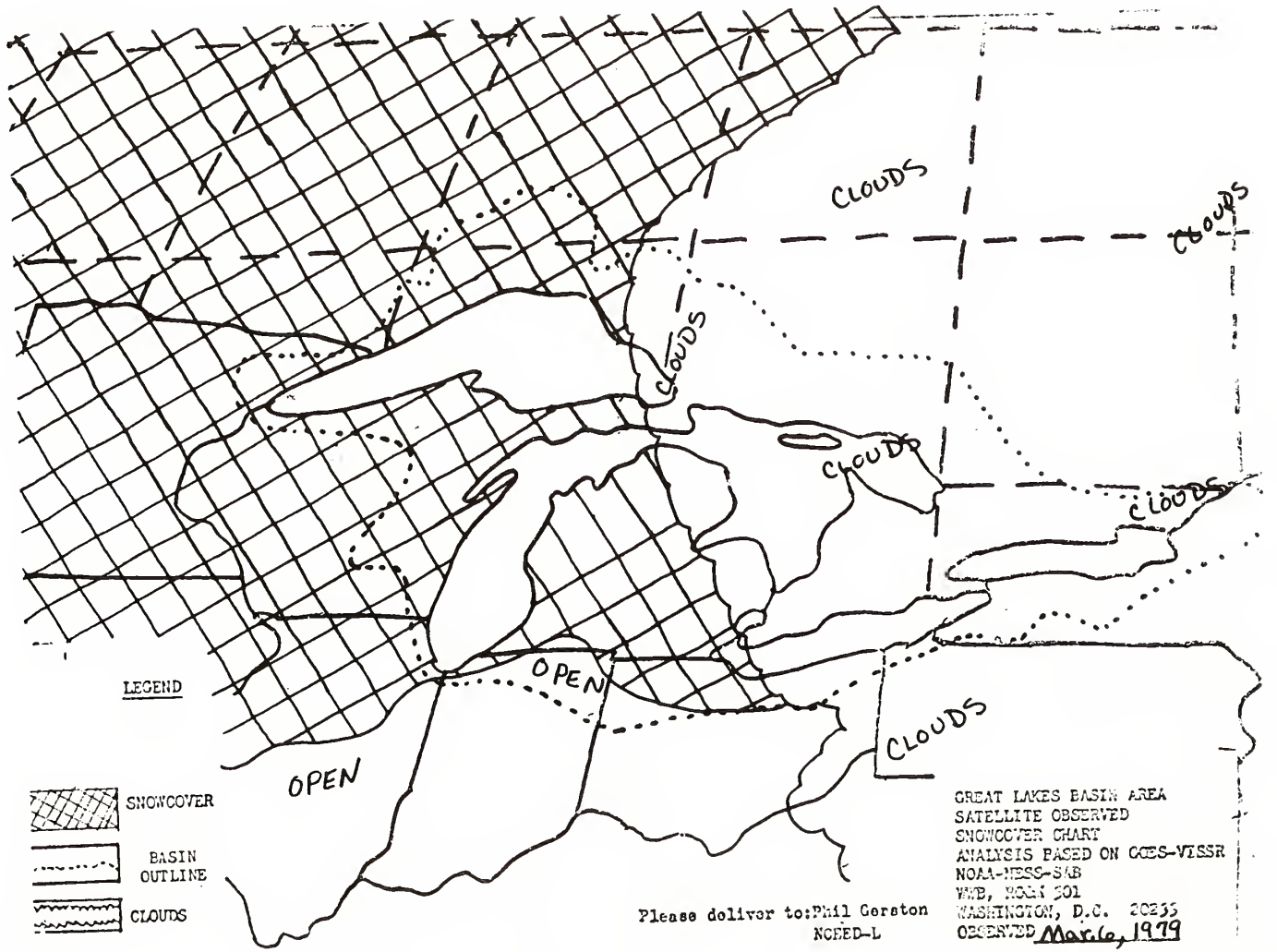


Figure 52. Great Lakes Region Snow Cover Analysis

C. Northern Hemisphere Snow and Ice Chart

Description. A chart of snow and ice coverage and their relative reflectivities is made weekly from analysis of geostationary and polar-orbiter visible imagery for the northern hemisphere. From a daily review of photographic data the analyst notes the changes in extent or brightness of the snow and ice fields when cloud free. Ice charts from the Joint Ice Center (see Ice Charts) and surface weather reports help confirm the interpretation of satellite data. After seven days of data have been compiled, an 8.5 by 11 inch polar-stereographic projection map (figure 53) with a scale of 1:50M is prepared and sent to users. At the end of each month a monthly mean of snow and ice boundaries is drawn (figure 54) and distributed to users. This product is used in the areas of snow-and ice-limit tracking, albedo studies, long-range weather forecasting, and various research projects.

Accuracy. For areas where several observations are made an accuracy of ±50km can be achieved. Limits to this accuracy arise from persistant low-level cloud decks, mountain affiliated cumulus, etc., having characteristics similar to a snow or ice field.

Primary users. The National Meteorological Center and various forecasting and research concerns and archived by SDSD of NCC.

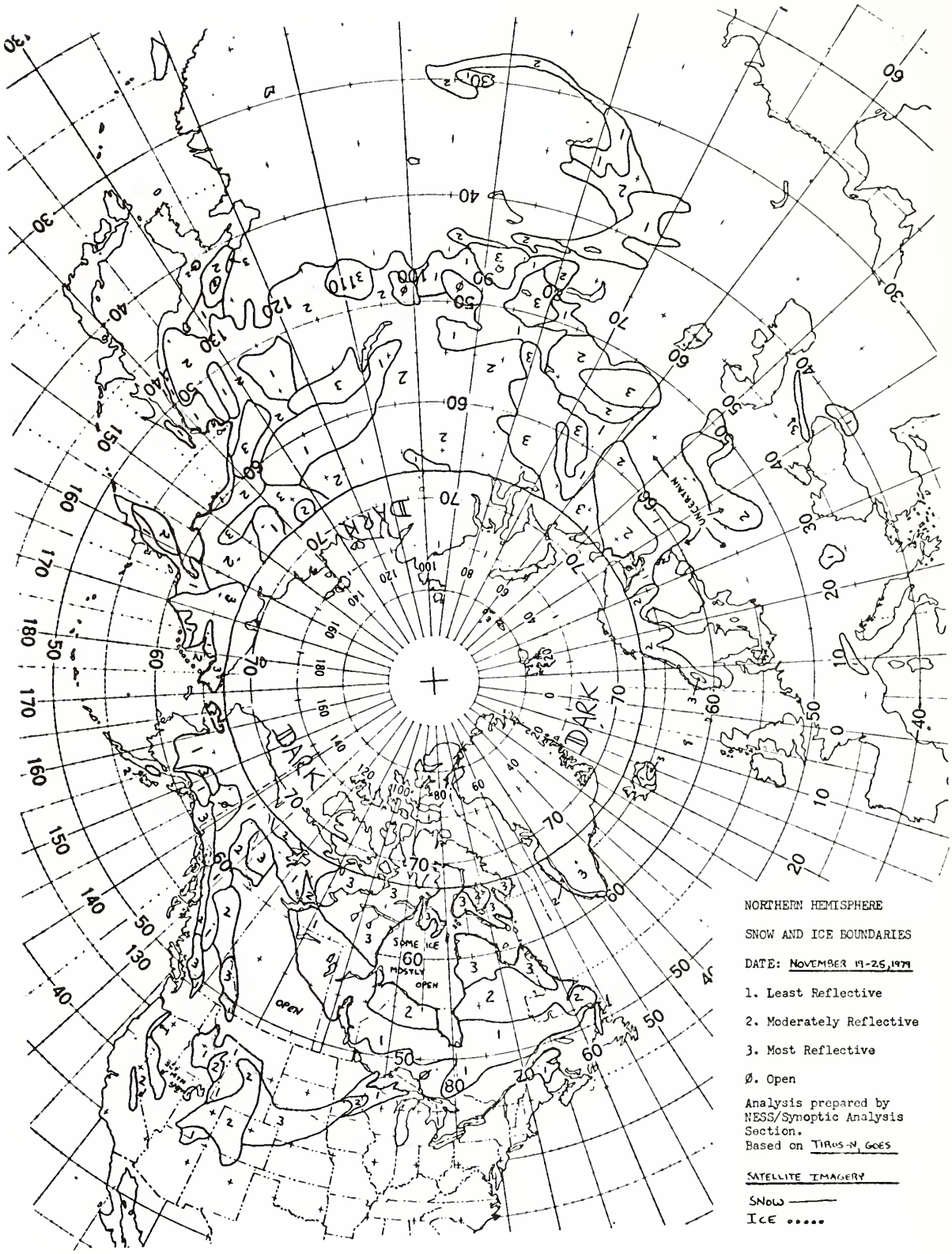


Figure 53. Northern Hemisphere Snow and Ice Chart

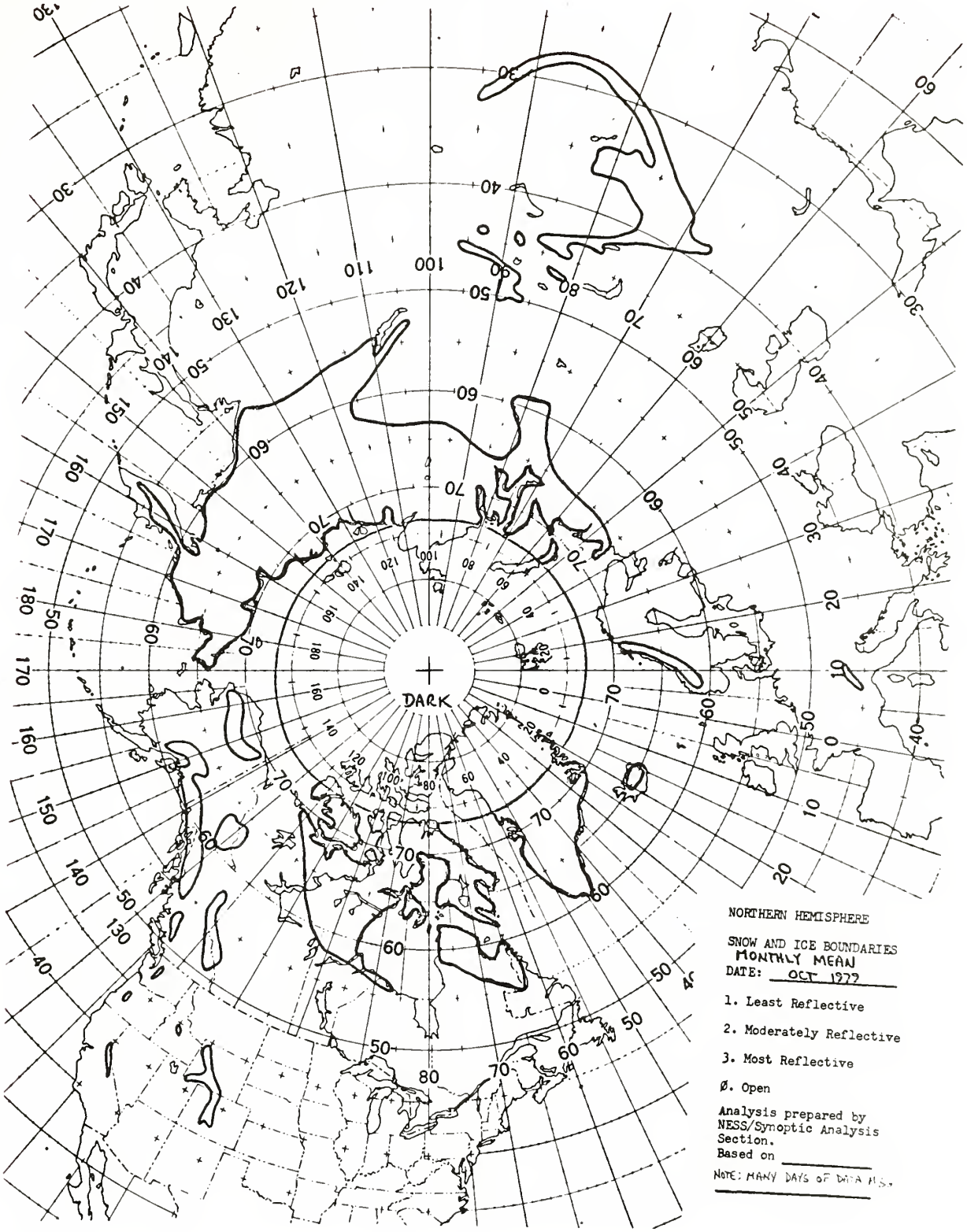


Figure 54. Monthly Mean Northern Hemisphere Snow and Ice Boundaries

TABLE 4
NESS Product and Services Summary

Product description	Accuracy	Spatial resolution	Map Scale	Geographic coverage	Output format	Schedule	User	Archive location
I. IMAGE PRODUCTS								
A. GEOSTATIONARY SATELLITES								
1. Full-disk (VIS and IR):								
East GOES	--	4 km VIS, 8 km IR	--	Pole to Pole, 65 W to 165 E	Photographic display and archive tape	At hour and half hour	NWS, NMC, NESS and Government, universities, and private research	SDSD
West GOES	--	4 km VIS, 8 km IR	--	Pole to Pole, 15 W to 145 E	"	At 15 and 45 minutes after the hour	"	SDSD
IR-enhanced	--	8 km	--	E & W GOES	"	E & W GOES	Applications Division	Applications Division
Sectors (VIS and IR):	--	1, 2, and 4 km	--	Specific areas; (see text)	"	E & W GOES	NWS, NMC, NESS and Government, universities, and private research	SDSD
2. Movie loops (VIS/IR/IR-enhanced)	--	1, 2, 4, 8 km	--	"	80 or more joined in stop, flow or alternated stop loop	In-house/daily, others on request (see text for list)	NESS - Applications Division and Winds Section	Applications Division and SDSD
TV filmstrips	--	2 km	--	Continental United States	Commercial TV film	Daily	Commercial TV	SDSD
3. U.S. cloud cover depiction	--	"	--	"	Photographic display, surface analysis chart and weather summary	Daily	NOAA Hdqtrs, NESS, ERL's, NASA, DOC, news media	SDSD
4. Daily Weather Picture	--	"	--	"	Photographic display and weather summary	3/day	Wireservices, TV and newspapers	No Archive

Table 4 (continued)

Product description	Accuracy	Spatial resolution	Map Scale	Geographic coverage	Output format	Schedule	User	Archive location
I. IMAGE PRODUCTS								
B. POLAR-ORBITING SATELLITES								
1. Stretched, Gridded, Pass-by-Pass Imagery (VIS and IR)	Nominal ±10 km grid placement	4 km	--	Global	Stretched, Gridded photographic strips, archive tape	Daily	NWS, DOD, NESS	SDSD
2. Hemispheric polar-stereographic mosaics (VIS and IR)	--	14.8 km - equator 29.6 km - poles	1:480 M	Northern and Southern Hemispheres	Mapped photographic displays and archive tape	Daily	NESS, ERL's, DOD	SDSD
3. Polar-stereographic quadrant mosaics (VIS and IR)	--	"	1:40 M	"	Mapped photographic displays	Daily	NESS, NWS, DOD	No Archive
4. Mercator mosaics (VIS and IR)	--	9.8 km - equator 7.5 km - 40° N	1:180 M	Northern and Southern Hemispheres to 40 N or S	"	Daily	NESS, NWS, ERL's, DOD	SDSD
5. Local Area Coverage images (VIS and IR)	--	1.1 km	--	Selectable orbit segments	Photographic displays and digital tape archive	Daily selectable orbit segments	NESS, NWS, ERL's, NMFS, DOD, NASA, Oceanographic and hydrological community, research concerns	SDSD
6. Seven-day minimum brightness composite (VIS and IR)	--	1:75 M	1:120 M	Northern Hemisphere from 20° N to Pole Southern Hemisphere from 50° S to Pole	Photographic displays and digital tape archive	Daily	NESS	SDSD

Table 4 (continued)

Product description	Accuracy	Spatial resolution	Map Scale	Geographic coverage	Output format	Schedule	User	Archive location
II. IMAGE SERVICES								
A. GEOSTATIONARY SATELLITES								
1. SMS/GOES facsimile displays (VIS and IR)	--	VIS: 4 x 4 km IR: 4 x 8 km		Continental United States--~55-120 W long and 15-60 N lat.; Eastern United States and Atlantic--~20-90 N long. and 15-60 N lat.; Southern South America--~25-80 W long. and 10-50 S lat.; U. S. West Cost and Pacific-- ~115-180 N long. and 15-60 N lat.; Western United States and Pacific-- ~105-180 W long. and 15-60 N lat.	Facsimile display	24-hour schedule (see latest NWS FAX list)	NWS, DOD, NESS, private meteorology, universities, research concerns	No Archive
2-3. SMS/GOES WEFAX link: SMS/GOES and NOAA polar-orbiter data in VIS and IR	--	Same as photographic imagery	1:80 M	Specified areas (see latest NESS WEFAX list)	Facsimile - satellite relayed broadcast	24-hour schedule (see latest NESS WEFAX list)	Foreign and domestic weather concerns with S-band receiving equipment	No Archive
4. GOES - Direct readout	--	Same as full disk and sector displays	--	Same as full-disk and sector displays	Photographic imagery	Same as full-disk and sector displays	Foreign and domestic Government, universities, commercial organizations, research concerns, amateur ground station operations	No Archive
5. GOES - Tap VISSR data		"		"	"	"	Private meteorology	No Archive

Table 4 (continued)

Product description	Accuracy	Spatial resolution	Map Scale	Geographic coverage	Output format	Schedule	User	Archive location
II. IMAGE SERVICES								
B. POLAR-ORBITING SATELLITES								
1. Polar-orbiting satellite facsimile displays (VIS and IR)	--	1:120 M - mercator 1:30 M - polar stereographic	1:20 M	Specified areas	Facsimile display	Daily, selected passes	NWS, DOD, NESS, private meteorology, universities, research concerns	No Archive
2. Polar-orbiting satellite - direct readout	--		--	Area of view at time of readout	Photographic digital imagery and alphanumeric data	Daily passes	Foreign and domestic government agencies, universities, commercial organizations, research concerns, amateur ground station operators	SDSD
III. METEOROLOGICAL PRODUCTS								
A. Satellite winds (from GOES): low-, middle-, high-level cloud motion vector field messages	See text	--	--	Global ocean areas	Raw numeric data, chart form and archive cloud motion vectors-archive tape	00Z and 12Z daily for distribution at 03Z and 15Z	NMC, USAF, USN, NWS, NESS, and research concerns	SDSD

Table 4 (continued)

Product description	Accuracy	Spatial resolution	Map Scale	Geographic coverage	Output format	Schedule	User	Archive location
III. METEOROLOGICAL PRODUCTS								
B. Atmospheric soundings (from Polar orbiter):								
Layer-mean temperatures (°K)		Nominal 250 km near sub-satellite track	--	Global	Computer disk - 24 hour rotating files, archive tapes	Continuous-orbit-by orbit	NMC, global weather centers, DOD	SDSD
SFG-850 mb 300-200 mb 30-10 mb 850-700 mb 200-100 mb 10-05 mb 700-500 mb 100-70 mb 05-02 mb 500-400 mb 70-50 mb 02-01 mb 400-300 mb 50-30 mb 01-0.4 mb	SFG-850 mb ±2.5 K 850-tropopause ±2.25° K trop.-2.0 mb ±3° K 2.0 - 0.4 mb ±3.5° K							
Layer precipitable water (mm) Surface-700 mb 700-500 mb above 500 mb	30%	"	--	"	"	"	"	"
Equivalent blackbody temperatures (°K) for 20 HIRS/2 stratospheric channels. 4 MSU channels, 3 SSU channels.	±2° K	Nominal 250 km near sub-satellite track	--	Global	Computer disk-24 hour rotating files, archive tape	Continuous orbit-by-orbit	NMC, Global weather centers, DOD	SDSD
Thickness (m) and layer-mean temperatures (°K) between selected standard pressure levels.	In areas of single layer layer cloud cover <50%, ±2°K (and equivalent Δz)		--	"	"	"	National and Global Tele-communications Service (GTS) customers	"
Precipitable water (mm) between selected standard pressure levels	±30%	"	--	"	"	"	"	"

Table 4. (continued)

	Product description	Accuracy	Spatial resolution	Map Scale	Geographic coverage	Output format	Schedule	User	Archive location
B.	Atmospheric soundings (from Polar orbiter):								
	Clear radiances $mW/(m^2-sr-cm^{-1})$	±2%	"	--	"	"	"	"	"
	Earth-located, calibrated radiances from SSU plus selected HIRS/2 and MSU channels.	Instrument specifications	"	--	"	"	"	British Meteorological Office	British Meteorological Office

Table 4 (continued)

Product Description	Accuracy	Spatial resolution	Map Scale	Geographic coverage	Output format	Schedule	User	Archive location
III. METEOROLOGICAL SERVICES								
C. Global Heat Budget: 1) Daytime Longwave flux 2) Nighttime Longwave flux 3) Reflected Energy or Equivalent (albedo, absorbed) 4) Available Solar Energy (calculated field)	7 watts/m^2 reflected and outgoing energy	Observations - 100 km	--	Global	Digital Tape - a) gridded earth-located arrays b) 2.5° x 2.5° mercator map array c) 125° x 125° polar map array Quality Control photographic image	Twice/day IR flux, once/day reflected, energy monthly (time averaged)	NWS-Long range prediction group	SDSD
D. WEATHER SUMMARIES AND BULLETINS								
1. Satellite Interpretation Message (SIM)	±6 n. Mi. (8.4 km)	--	--	Continental United States	Teletype	Washington, D.C., SFSS: 8/day Kansas City SFSS: 8/day Miami SFSS: 1/day (in-house) Honolulu SFSS: 2/day Anchorage SFSS: 2/day	Domestic weather operations	No Archive
2. Satellite Weather Bulletins	--	--	--	Atlantic, Pacific, Indian Oceans	Teletype	As needed	Foreign and domestic weather operations	No Archive
3. Satellite Weather Summary and TV movie overlay	--	--	--	Continental United States	Teletype message and acetate overlay	Daily	Commercial TV Networks	No Archive
4. Cloud Top and Tropopause message	±3000 ft	1° lat/long	1:20 M	GOES East and West Area	Teletype	4/day	NMC, NWS forecast offices and aviation interests	NESS-SAB (1 week)
5. Tropical Disturbance Summary	±30 n. mi. (42 km)	--	--	Atlantic and East Pacific (to 180 W), West and South Pacific, Indian Ocean	Teletype	2/day/area	Foreign and domestic weather operations	No Archive

Table 4 (continued)

Product description	Accuracy	Spatial resolution	Map Scale	Geographic coverage	Output format	Schedule	User	Archive location
IV. OCEANOGRAPHIC PRODUCTS								
A. SEA SURFACE TEMPERATURE PRODUCTS								
1. Sea Surface Temperature Observations	±1.5°C Absolute ±1.5°C Relative	Nominal 50 km	--	Global	Computer Disk and Digital Archive Tape	Daily (disk) Weekly (tape)	NESS, NWS, International Oceanographic Services, Environmental research, Commercial Fisheries	SDSD
2. Global Sea Surface Temperature monthly Observation mean	"	2.5° lat/ long, 250 km grid	--	Global	Computer Disk Digital Archive Tape Contour Analysis Chart	Monthly (disk) Yearly (tape) monthly (chart)	"	SDSD
3. Sea Surface Temperature Regional Scale Analysis	"	0.5° lat/ long, 50 km grid	1:22 M	1) 5°N - 53°N, 52°W - 100°W 2) 15°N - 63°N, 97°W - 145°W 3) 15°N - 63°N, 142°W - 170°E	Computer Disk Digital Archive Tape Contour Analysis Chart Photographic Q.C. Image	Weekly (disk) Monthly (tape) Weekly (chart) Weekly (photo)	"	SDSD
4. Sea Surface Temperature Global Scale Analysis	±1.5°C Absolute ±1.5°C Relative	1.0° lat/ long, 100 km grid	1:45 M	Global Charts - 50° x 50° lat/long	Computer Disk, Digital Archive Tape, Computer Terminal Display, Contour Analysis Chart, Photographic Q. C. Image	Daily (disk) Semi-Monthly (tape) On-demand (terminal) Weekly (chart) Daily (photo)	NESS, NWS, International Oceanographic Services, Environmental research, Commercial fisheries "	SDSD
Sea Surface Temperature Climate Scale Analysis	±1.5°C Absolute ±1.5°C Relative	5.0° lat/ long, 500 km grid	--	Global	Computer Disk Digital Archive Tape Photographic Q.C. Image	Daily (disk) Monthly (tape) Daily (photo)		SDSD
5. Great Lakes and Coastal Surface Water Temperature Analyses	1.5° C Absolute 0.5° C Relative	1 km Great Lakes 5 km Coastal Zones	Varies with type of transmission	Great Lakes and U.S. Coastal Regions	Gridded Analysis	Weekly	NWS, environmental research, commercial marine concerns	SDSD

Table 4 (continued)

Product description	Accuracy	Spatial resolution	Map Scale	Geographic coverage	Output format	Schedule	User	Archive location
IV. OCEANOGRAPHIC PRODUCTS								
B. ICE CHARTS								
1. Great Lakes Ice Chart	±5 km	1 km	Varies with type of transmission	Great Lakes	Gridded analysis	Weekly	Commercial Marine Transportation, USN, USCG, NMFS, research concerns	SDSD
2. Polar Regional Ice Charts	±5 km	1 km	Alaskan - 1:5 M Arctic - 1:10 M Antarctic - 1:10 M	Polar Ocean Ice Regions	Gridded Chart	Daily and Weekly	"	SDSD, Joint Ice Center (Suitland, Md)
C. OCEAN CURRENT ANALYSES								
1. Gulf Stream Wall Bulletin and Analysis	±5 km	1 km	Varies with type of transmission	U.S. Coastal waters of the Gulf of Mexico and east coast	Teletype Message Gridded Analysis	3/week (bulletin) weekly (analysis)	Coastal Marine Transportation, Fisheries, USCG, recreation and research concerns	SDSD
2. West Coast Thermal Front Analysis	±5 km	1 km	--	U.S. West Coast out to 4° longitude	Gridded Analysis	2/week	Albacore tuna and salmon fisheries, environmental research concerns	SFSS - San Francisco, CA SOS/NWS - Seattle, WA

Table 4 (continued)

	Product description	Accuracy	Spatial resolution	Map Scale	Geographic coverage	Output format	Schedule	User	Archive location
V.	HYDROLOGICAL PRODUCTS								
A.	River Basin Snow Cover Observations	±5%	1 km	--	Selected basins (see text)	Percent covered analysis	Daily and weekly, depending on basin	OH/NWS, Corps of Engineers, Soil Conservation Service, Bureau of Reclamation, U.S.G.S.	SDSD
B.	Regional Snow Cover Analysis	±5 km	1 km	1:7.5 M and 1:10 M	Great Lakes, Northwestern U.S., Himalayas	Gridded Analysis	2/week - Western Hemisphere 1/week - Eastern Hemisphere	Corps of Engineers, Joint Agriculture Weather Facility, NWS	SDSD
C.	Northern Hemisphere Snow and Ice Chart	±5 km	1 km	1:50 M	Northern Hemisphere	Gridded Analysis	Weekly (Analysis) Monthly (mean)	USN, other marine interests	SDSD

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